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RESCUE APPLIANCES IN THE MINES OF FRANCE.

By Jacques Boyer.

The movement for the better safeguarding of life and limb from occupational accidents, whether in mining, railway service, or mechanical industries, is gaining force and volume. Strong evidence of this in the United States is the association, on the committee of direction of the new Museum of Safety Devices and Industrial Hygiene, of leading representatives of every one of the great engineering and technical journals. Men of this calibre have no sympathy with sensationalism, but they have the best knowledge of existing ills and of the practical measures effective for reform. We take the timely occasion afforded by the exposition of safety devices and protected machinery, opened in the museum this month, to present M. Boyer's review of Continental practice in safeguarding the mine worker. It will be followed next month by another paper exhibiting the appliances for a wider range of industry assembled in the museum of the *Conservatoire des Arts et Métiers*.—THE EDITORS.

IN recent years a number of terrible explosions of fire damp have agitated public opinion on both sides of the Atlantic. To cite but a few, we may recall the sadly well-known explosion of Courrières, near Lens, France, which killed, burned, or asphyxiated 1,150 miners March 10, 1906; that of the mines of Reden at Sarrbruck, Germany, which cost the lives of 170 men January 28, 1907; more lately still the three very recent catastrophes which took place in the United States during the month of December, 1907—at Monongah, West Virginia, (305 fatalities), at Tuscaloosa, Alabama, (67 fatalities), and at Jacobs Creek, Pennsylvania, (170 fatalities).

Specialists have devoted their study toward means for avoiding catastrophes of this kind, so far as possible, or at least for diminishing their extent, by perfecting methods of mining, improving ventila-

CENTRAL RESCUE STATION ORGANIZED AT THE COURRIÈRES MINES, MAR. 10, 1906.
The soldiers are preparing to stretch piping from the air pumps.

tion, and securing the use of safety lamps and explosives in gaseous mines. Particularly, just now, engineers are focusing their attention upon respiratory apparatus, and we may with advantage consider the principal types which are in use in the mines of France.

Immediately after the catastrophe at Courrières, M. Barthou, the Minister of Public Works, brought the question before the *Conseil-Général des Mines,* and engineer Weiss was charged with an official mission to Germany and Austria in pursuit of the subject. The Colliery Commission of France, on its own part, selected MM. Bouteille, Morin, and Chavanne to accompany M. Weiss. The information gathered in the course of these inquiries led to the issuance of a ministerial decree (April 15, 1907) directing that mining companies in France should provide, for all workings where more than 100 men are employed under the fullest operation, "*portable respiratory apparatus* ready for immediate use and permitting the wearer to remain at least *one hour* in an irrespirable atmosphere." The regulations contained, further, various prescriptions relative to the apparatus to be kept at a central rescue station, where, under the direction of an engineer or an inspector, a rescue corps of at least ten should be properly trained. (Article VI.) Finally, all the requirements laid down by the Ministry in the decree were to be fulfilled within one year from the date of its publication in the official journal

—that is, to say, all the mines of France (unless specially exempted) must conform to them by April 18, 1908.

Let us now glance hastily over the history of respiratory appliances in order to estimate better the degree of perfection attained in those which are at present in use.

Certain German and Austrian constructors have presented respiratory appliances as a recent invention, but in reality apparatus of this character dates rather far back. The first practical attempts in this direction were made in 1824, and were due to French engineers. At that period the administration of the French mines addressed to all its prefects a memorandum in the course of which are found prescribed:—

1.—An apparatus with a nose clip, a mouth piece, and a respiratory tube for free air, developed experimentally by Pilâtre de Rozier in 1785 and completed later by M. Delaunaye's introduction of an anti-memphitic respirator with two valves, and of a lamp supplied with air through a branch of the respiratory tube.

2.—An apparatus with respiratory tubes attached to air reservoirs carried on a rescue car. The memorandum indicated the possibility of replacing the air in these reservoirs by oxygen, as well as that of increasing the amount of air or oxygen carried by compression within reservoirs of sufficient strength.

3.—An apparatus with respiratory tubes to be supplied by blowers and tubing or piping for the conveyance of the air.

The circular which accompanied this memorandum from the Ministry requested the mining companies to procure a number of these appliances, but the appeal was not regarded, and it is necessary to pass over a period of forty years before any new progress is to be observed.

In 1864 we may note the appearance of the Galibert respirator composed of a reservoir of pure air which the miner carries upon his back, a respiratory tube leading from the bottom of this reservoir to his mouth, and a tube for exhalation leading from his mouth to the top of the reservoir. By this arrangement, the user had between his lips an ivory mouth-piece with two orifices, and by closing these alternately with the tongue he might inhale air from the bottom of the reservoir and exhale it again to the upper part. It was possible for a man to breathe thus for fifteen to twenty minutes, but the air became greatly vitiated. To overcome the increasing discomfort which the rescuer must thus suffer Galibert conceived the idea of modifying the original form of his apparatus. He secured a partial regeneration of the air exhaled from the lungs by causing it to pass

over a substance which would remove the carbonic acid. A little later (1870-1) Rouquairol-Denayrouze conceived his *aerophore*, which consists of a large sheet-steel tank containing air compressed to 20 atmospheres and carried either on the back or on a rescue car. A tube connects this reservoir with a mouth-piece provided with a pressure regulator, the nostrils of the user being closed by a pince-nez. Shortly afterwards Fayol described various types of respiratory apparatus in which he abandoned the use of compressed air in order to secure appliances little subject to derangement.

About 1884 Dr. Regnard applied, in an individual portable apparatus, the principle of revivification of the air by means of a reservoir of oxygen and of the passage of the exhaled air into another receptacle filled with pumice-stone saturated with a solution of caustic potash.

Unhappily, as M. Haton de la Goupillière states, all these appliances had a common failing, due to the infrequency of their use: "At the critical moment the parts of the apparatus would not work, and the men lacked familiarity with their use." Furthermore, the respiratory apparatus thoroughly tested from 1873 to 1880 at the mines of Commentry, under the direct inspiration of M. Fayol, little by little passed in disuse. The problem was taken up again in Germany and Austria only during the last years of the Nineteenth Century. But French inventors and constructors, working quietly, have been producing respirators which, little by little, have won their way by their own merit and without useless proclamations. In particular Lieutenant Vanginot of the Paris Fire Department has invented an apparatus of which the earlier forms appeared in 1903 and the most recent in 1907. During these four years this respirator has proved itself in many places, even as far as in Russia and Mexico.

There are now two types of rescue apparatus in use in French mines:

1.—Portable appliances which permit the bearers to move at will through the mine galleries and upon which we shall dwell particularly.

2.—Apparatus with pumps and piping, having a much more limited range of action, which are adapted for the prosecution of work rather than for rescue.

The portable appliances in their turn may be divided into two classes: First, regenerative apparatus, and second, apparatus using ordinary air; these latter, although they give a more limited working period than the former, appear to demand less nicety of manipulation. Furthermore, air exists everywhere, while at the moment of a disaster oxygen, potash, and other chemical necessaries may be lacking. In the

FIG. 1. THE DRAEGER-GUGLIELMINETTI RESPIRATOR, SEEN FROM BEHIND.
Showing the oxygen reservoir, the pressure-reducer and the regenerator for exhaled gases.

former class (much more largely employed in Germany and Austria than in France) we may note particularly the ancient *pneumatophores* (Walcher, Mayer-Pilar, and Giersberg types) which generally consist of oxygen tanks delivering (usually without any regulator) into an air-tight bag, from which the man inhales and into which he exhales. An absorbent, usually liquid, contained in this reservoir, purifies this air by the removal of the carbonic acid. They did not work very well, and they have been abandoned, as has also the "Shamrock"

—an apparatus with a mouth-piece and a pince-nez, having a pressure regulator, a solid absorbent inclosed in a cage within the air-tight sack, in which, also, circulation was mechanically maintained.

The Draeger-Guglielminetti respirator merits larger notice, but its mechanism is complicated and the parts are fragile (Figure 1). It comprises a reservoir of oxygen, a pressure-reducing regulator, a respiratory mask, and a regenerator for the products of respiration. The oxygen tank consists of one or two steel reservoirs of one litre capacity each, placed horizontally and containing oxygen compressed to 110 atmospheres. This storage supply is maintained either by replacing the exhausted flasks with others, ready-filled at the oxygen-generating station, or by refilling the empty flasks in place, from larger oxygen reservoirs.

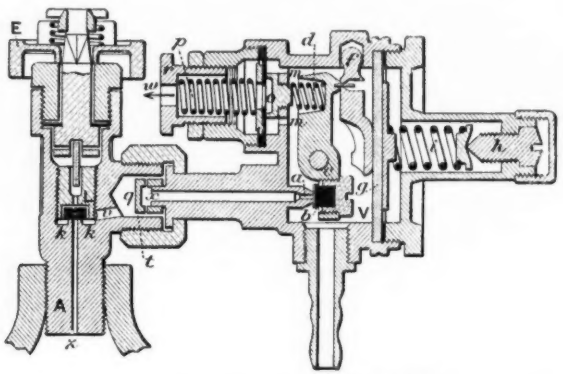


FIG. 2. SECTION OF PRESSURE-REDUCING AND REGULATING VALVE, DRAEGER-GUGLIELMINETTI APPARATUS.

The regulating and reducing valve (Figure 2) has a double purpose—to lower the pressure of the oxygen issuing from the reservoir and to control its volume. It is composed of two elements, the reducer, properly so-called, and the safety valve. The stop valve, which is shown at the outlet of the oxygen tank, is pierced by a canal z through which the gas escapes; this canal, formed by a small piece of ebonite L which is regulated by the screw E, opens into a circular chamber k. The movement of the screw E obstructs more or less the entrance of the oxygen into the passage k and its exit through v, another channel which establishes communication between the circular chamber k and the larger space q. The oxygen having reached this chamber passes out from it through the tube x, after being

forced to pass through two small openings in the piece t. At a it meets an ebonite stopper b attached to the extremity of a lever c. This lever is controlled by the spring d. The oxygen issuing from a expands in a chamber V, where it presses against the membrane g against which the spring i bears in opposition to the spring d, the latter operating through the lever f. The pressure of the spring i is regulated by the screw h; this regulation is adjusted to secure a determined pressure for the oxygen in the chamber V; if the pressure of the gas decreases, the spring i forces the membrane g toward the left. This moves the lever f which, in its turn, compresses the spring d, engaging in its recoil the lever c. The ebonite piece b then in its turn enlarges a little the opening at a, affording a larger passage for the escape of the oxygen flowing from the reservoir and re-establishing the desired pressure in the chamber V. The contrary effect is produced whenever the pressure in chamber V begins to increase. Thus the expanded oxygen passing through the orifices m m, to the safety valve, is in a state of practically uniform pressure. The oxygen leaving the orifices m m enters the safety valve, where it presses upon the ebonite diaphragm o which is hollowed out at the centre and held by the spring p. The tension of this latter is regulated by the hollow screw r. The oxygen escapes at w and passes to the respiratory mask. The tension of the screws h and r is adjusted in advance. When the apparatus is to be used, the screw E is manipulated to permit the entrance of oxygen into the pressure regulator. The oxygen, after its reduction in pressure, flows to the respiratory mass, which is held in place by a sort of pneumatic gasket which fits over the face and is inflated at the moment of use. In the lower part are two sacks, one of which receives the oxygen, and the other the exhaled air, the entrance of the oxygen and the exit of the exhaled breath being governed by the play of two valves operating in opposite directions, as shown in Figure 3.

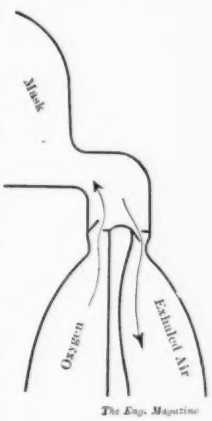


FIG. 3. DIAGRAM OF DRAEGER-GUGLIELMINETTI RESPIRATORY MASK.

In newer forms of the apparatus a special arrangement permits the exhaled air still containing oxygen to pass two or three times to the lungs, and in cases of heavy demand this might offer an important advantage. The regenerator (Figure 4) serves the purpose of fixing the carbonic acid exhaled from the lungs and thus rendering

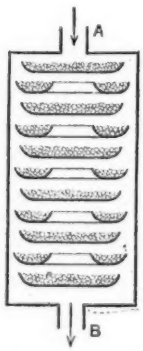


FIG. 4. SECTION OF REGENERATOR FOR EXHALED GASES, DRAEGER-GUGLIELMINETTI APPARATUS.

the air again respirable. The purified air at its exit from the regenerator passes into the inlet tube for the pure oxygen. The regenerator itself is composed of two sheet-steel cylinders placed vertically. In the interior are metallic baskets containing fragments of potash, about which the exhaled air circulates, giving up its carbonic acid to the potash before it passes out of the regenerator. As its temperature is raised by the heat given out in the chemical combination of the potash with the carbonic acid, it must be cooled before it is mixed with the oxygen flowing from the reservoir; the temperature reducer is a sheet-steel cylinder with double walls through which the air is made to circulate. As may be seen, all these devices are most ingenious and most complicated, and therefore up to the present the Draeger-Guglielminetti apparatus is little employed in French mines.

The *pneumatogène* of MM. Bamberger and Friedrich Bock is likewise a regenerative appliance. It is based on the following reactions which take place when aqueous vapor and carbonic acid (both products of respiration) are passed over the peroxide of sodium and potassium.

$$Na\,KO_3 + H_2O = Na\,OH + KOH + 2O$$
$$Na\,KO_3 + CO_2 = Na\,KCO_3 + 2O$$
$$CO_2 + Na\,OH + KOH = Na\,KCO_3 + H_2O$$

The products of respiration (CO_2 and H_2O) are absorbed and the oxygen is restored to the wearer of the rescue apparatus. The *pneumatogène* ready for operation is shown in Figure 5 and its operation is described as follows:

FIG. 5. THE "PNEUMATOGÈNE" IN USE.

The peroxide reservoir, shown in section in Figure 6, consists of a cylindrical metallic receiver A closed at both ends by caps D_1 and D_2. In the upper part is a small dome F_1, into which opens the orifice F of the respiratory tube, the mouth-piece of which the rescuer holds in his lips. In the lower part is a little

reservoir G which is provided with a tube H leading to the air bag. When the apparatus is not in use, but merely ready for operation, the communicating openings a, b, are closed by little sheets of lead foil. At the moment when the device is put into operation these lead sheets are perforated with the aid of a mechanism consisting of the operating rods c and d and the perforating cutters e and f. S_1 and S_3 are filter plates which break up the circulation of the air into a number of circuits. These plates serve, also, to filter the air and to remove from it the particles of alkaline carbonates which might be entrained. As extra precaution, care is observed to place at E, between two perforated plates of metal, an asbestos composition forming a third filter which removes every trace of solid particles.

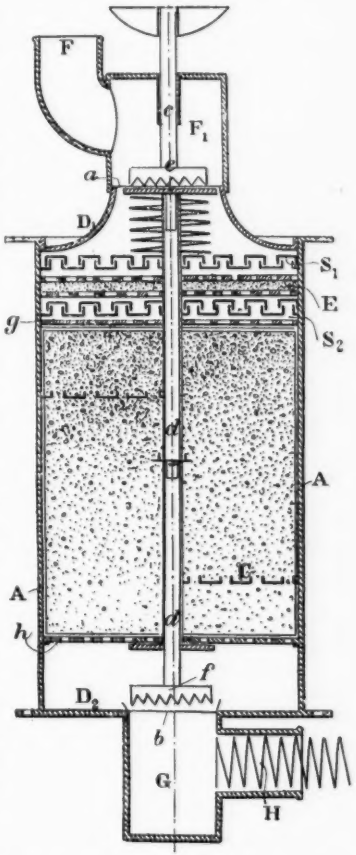


FIG. 6. SECTION OF THE RESERVOIR OF THE "PNEUMATOGÈNE."

The ordinary charge is 250 grammes of peroxide of sodium and potassium, which is held between the perforated diaphragms g, h; but as there is a tendency for the mass to swell with the progress of the chemical combinations, and as this would interfere greatly with the free circulation of air in the apparatus, perforated frames C are placed at various heights within the body of the apparatus, thus preventing the difficulty. Finally, as the apparatus becomes considerably heated by the reaction, it is provided with an exterior insulating jacket with air circulation. The apparatus, as shown in Figure 5, is carried upon the chest; carriage on the back is discarded in order to avoid the long stretches of tubing, which almost always become defective.

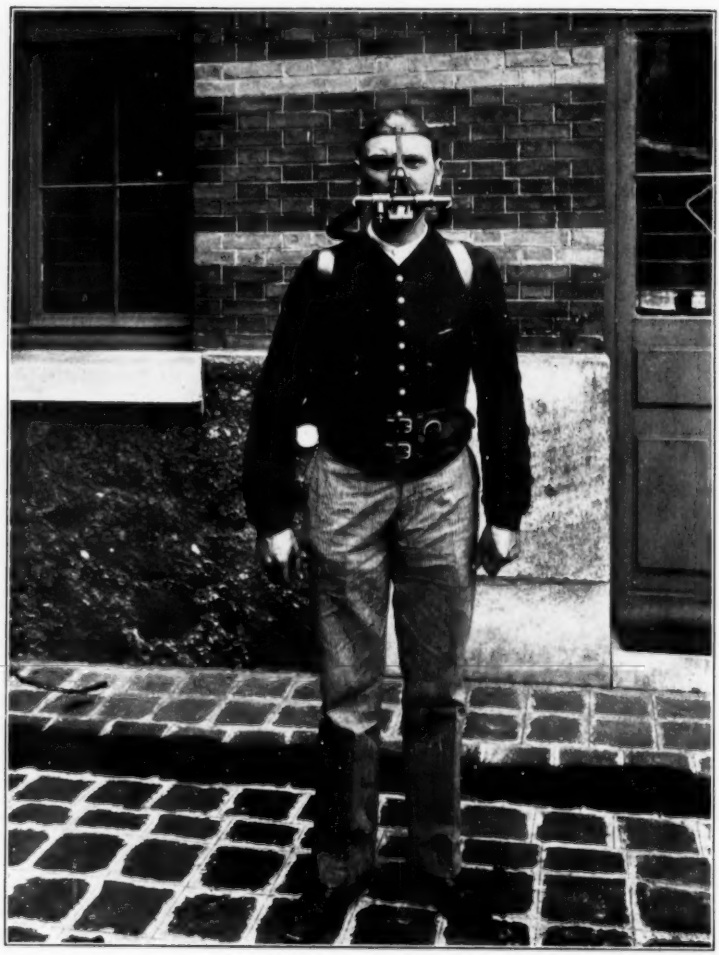


FIG. 7. FACE VIEW OF THE TISSOT RESPIRATOR IN SERVICE.

This early type of *pneumatogène* permits 30 to 35 minutes' stay in an atmosphere of irrespirable gas; as this working period is too limited, the inventors have made various improvements in the newer model. At first it was thought that increase in the dimensions of the receiver would alone suffice, but many difficulties were found, such as poor circulation of the air, tendency to stoppage of the tubes, etc. It was therefore found necessary to double, or more exactly to triple,

the old apparatus. The present type comprises, in fact, three similar receivers, of which two serve for use during the period of rescue work, the third being held in reserve for return to the air. Under ordinary operation only the two reservoirs are in service, but a little device permits the rescuer in case of need to bring the third into operation also. Having found, further, that the start is made with difficulty, and that it is necessary to force the air at first to quicken the reaction, the arrangement has been completed by the addition of a little reservoir containing 10 to 12 litres of oxygen or a small special apparatus containing binoxide of sodium capable of supplying immediately the few litres of oxygen necessary to start the operation. In order to avoid long tubing the apparatus is carried upon the chest, but the air bag is on the rescuer's back. The small apparatus with a single receiver weighs only 2 kilogrammes; the larger one complete about 3.5 kilogrammes. It serves equally well for "self rescue" or for the rescue of other persons. In the former case preference is given to the small model; in the latter to the type with three receivers. The *pneumatogène* is very light, easy to start and to operate. Finally, it is relatively inexpensive. In Austria its use is becoming more and more general. Many trials are reported in which the operators have remained for one hour, and some experimenters have been able to remain for two hours and a half without feeling serious inconvenience. In France its use is as yet but little extended.

The Tissot respirator dates only from 1907, but it appears to be one of the best conceived French apparatus of the type. Its general form and the manner of wearing it are shown in Figures 7 and 8. There are five essential parts in the appliance, which are described as follows:

1.—A nose-piece with valve, adjusted to the nostrils of the wearer by means of two nipples fixed on the tube, and attached firmly to a round cap by means of straps. The separation of the air currents of inhalation and exhalation is accomplished by two valves; a drain cock allows the discharge of accumulated water of condensation. The two valves are so constructed that it is impossible for them to stick even when they become saturated. The gas which has been inhaled is led by a rubber tube to a regenerator, where the carbonic acid is removed by a concentrated solution of potash; thence it passes to the reservoir bag.

2.—A regenerator fixed on the case, which serves also for the protection of the gas bag. This case or box is of metal, divided by partitions into four compartments designed for reception of the potash solution, and communicating by an orifice and two tubes. The

height of these tubes and their flanges prevents the solution of potash from being thrown from one compartment to another. The large capacity of the lowest compartment makes any splashing of the solution finally harmless, and the wearer of the apparatus may lie down or crawl in any position without any possibility of the potash passing from one compartment to another. A special arrangement of the partitions of the lower part of each compartment prevents the reduction of the absorbing surface when the wearer is stooped over.

3.—A reservoir sack for the air, made of very pliable impermeable fabric, in which the regenerated products of respiration are accumulated.

FIG. 8. TISSOT RESPIRATORY APPARATUS; SHOWING HOW THE RESCUER MAY CRAWL FLAT ON HIS STOMACH WITHOUT INCONVENIENCE.

4.—An automatic safety or escape valve of the slide type, operated by the walls of this air reservoir. When the pressure in this latter reaches from 2 to 5 millimetres of water the sack bears against a plate, pushing it backward and by means of a rod draws aside a disc, uncovering the orifice of the tube and allowing part of the gas to escape from the apparatus. When the pressure has diminished sufficiently the disc returns to the closing position and the plate is restored to its former place by the action of a spring. The very large surface presented by the sack (800 centimetres) permits a considerable force to be exercised for the operation of the valve, making its action certain, even at a pressure so low as to be imperceptible to the wearer.

5.—A receiver for compressed oxygen, provided with a reducer and a gauge by which a constant flow of oxygen is obtained and is regulated at will by the wearer so as to give 1, 1½, 2, or 2½ litres a minute. The oxygen flowing from this reservoir is conducted by a rubber tube to the inspirator apparatus. If 1,700 to 1,800 cubic centimetres of saturated potash solution, containing 1,700 grammes of potassium hydrate, are equally distributed among the compartments of the regenerator, and if a flask containing 300 to 350 litres of oxygen is supplied, it is possible for the rescuer to remain four to five hours in an irrespirable atmosphere, walking at the pace of 5 kilometres an hour, or to remain for two hours and a half at continuous and very fatiguing work. In trials made at the mines of Lens in July last, the Tissot respirator gave satisfactory results. In one of these, thanks to the apparatus just described, a man made a stay of three hours and a half and accomplished a circuit of 3.3 kilometres through difficult mine passages. Further than this, the miner may advance, crawling upon his stomach, no part of the apparatus (as the photographs show) being borne upon the chest to obstruct him.

Among the apparatus using ordinary air, principal mention may be made of the Vanginot respirator shown in Figures 9 and 10, which is coming into increasing use in the mines of France, and which has been in service for several years in the Paris Fire Department. To begin with, the Vanginot respirator, being of the compressed-air type, furnishes the user with a continuous supply of fresh air, and this without the aid of any cooling device requiring special or delicate parts which are often the cause of poor working with similar appliances. The natural explanation of this is the large absorption of heat due to the expansion of the air, which lowers the temperature of the flasks considerably and keeps them cool even in a heated atmosphere. Its strong construction insures it against derangement, and the very simple mode of replenishment gives it the incontestable advantage of furnishing to its users a respirable, natural atmosphere for an indefinite period, without having recourse to chemical products difficultly procurable, often dangerous to the user, and sometimes likely to be found spoiled at the moment of need.

The Vanginot apparatus consists of three parts:—

1.—A battery of air accumulators.

2.—An indicating reducing gauge.

3.—A respiratory mask or helmet.

The battery of air accumulators, which is composed of two steel flasks (Figure 11), is charged at a pressure of 150 to 250 kilogrammes (2,130 to 3,150 pounds per square inch) by means of a com-

pressor constructed specially for the service. The volume of air thus stored is sufficient for an hour to an hour and a quarter's use. We shall see later that an ingenious system of refilling permits this supply to be renewed by the replacement of the accumulators even in the midst of an irrespirable atmosphere in which the wearers may be working.

FIG. 9-10. FRONT AND REAR VIEWS OF THE VANGINOT RESPIRATOR.
The view from behind shows the air-accumulator battery, the pressure gauge, and other attachments.

The indicating reducing gauge, as its name indicates, lowers the pressure of the air contained in the flasks to an ordinary tension and supplies the user with a volume of expanded air, which may be further regulated by means of a so-called regulating valve, supplying a greater or less volume according to respiratory needs. This reducer-recorder is also employed to operate an alarm whistle, warning the rescuer of the reduction of pressure and of the approaching exhaustion of the compressed-air supply. The moment when this warning shall be given may be regulated at will, but with the ordinary ad-

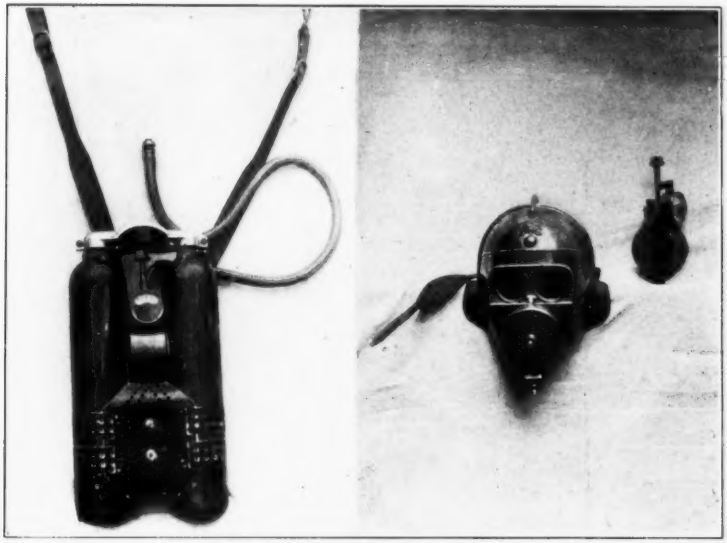


FIG. 11-12. AIR-ACCUMULATOR BATTERY, HELMET, AND REDUCING GAUGE OF THE VANGINOT RESPIRATOR.

justment the apparatus is supplied so regulated that the whistle will sound when the air supply is within fifteen to twenty minutes of exhaustion.

The respiratory mask with its crest resembles a fireman's helmet extended downward and forward so as to enclose the face completely. It is strong enough to protect the wearer's head from blows or falls of hard substances. The respirable air contained within the helmet is isolated from the external atmosphere by means of a pneumatic tube which can be inflated at will and which, adjusting itself to every contour of the face, assures most absolute safety so far as air-tightness is concerned, while it avoids all harshness of contact.

The discharge valve for the exhaled air is proof against any derangement. It consists of a simple membrane with large surface. The chest of the wearer is entirely free for carrying another person or any large burden. The wearer may stoop without fear in crawling through small openings. M. Le Breton, in a report presented to the Coal-Gas Commission, concludes as follows:

"The construction of the Vanginot apparatus is very simple, and to put it into service requires the easiest of manipulations—the opening of an easily-controlled stop cock."

In practical work the operator places the air accumulators on his

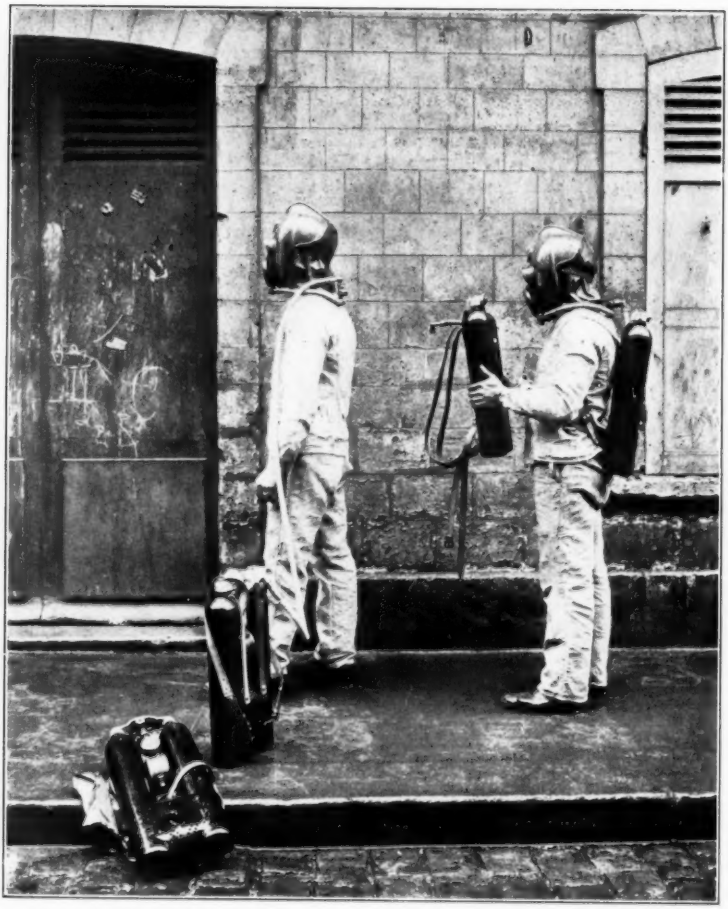


FIG. 13. RENEWAL OF AIR-ACCUMULATOR BATTERIES IN THE VANGINOT APPARATUS.

back like a knapsack, puts on the helmet, attaches this to the air battery, and opens the stop cock. Thus supplying himself with air, he may enter a deleterious atmosphere. A special arrangement permits the wearer of the apparatus to traverse any necessary distance before entering the irrespirable atmosphere without using the air supply stored in the battery. To accomplish this he raises a catch, opening a door in the helmet and putting himself in direct communication with the ordinary air, at the same time cutting off the flow from the storage supply. As he approaches the irrespirable zone he lowers

the catch, closing the door, and immediately finds himself supplied with air from the battery.

Assurance of the proper working of any automatic respiratory apparatus before it is carried into actual service depends upon the reliability of its mechanical parts. In the case of the Vanginot respirator, when the operator has put it on it is necessary only to open the stop cock of the air tank and immediately close it again. This action confirms the fullness of the storage tanks and actuates the indicator whistle. The indication of the figure 150 or 175 by the needle of the gauge, followed by two distinct blasts of the whistle, assures the wearer of his air supply for a known period, and also of its proper flow into the helmet. Finally, (and this is also an essential point) the rescuer will be warned at the definite moment when he has but fifteen or twenty minutes further air supply, and he may then retire from the dangerous atmosphere in which he is working or exchange the exhausted accumulator for a full one. To effect this, as shown in Figure 13, one of his fellows attaches to the three-way stop cock at the back of his helmet one of the full batteries held in reserve near by, using for this attachment a rubber tube provided for the purpose. He opens the valve of the accumulator thus attached; then, by a quarter turn of the three-way cock he opens a passageway into the helmet for the air from this new accumulator, at the same time cutting off the nearly exhausted one. The attachment of this latter is then unscrewed and it is easily replaced by a new one. By proper manipulation of the three-way cock this last accumulator is placed in communication with the helmet. The tube connected with the reserve by which the man has been supplied during the interim is detached, and he is again free to move at will. The whole process requires scarcely two minutes. It is easily seen that with a sufficient supply of reserve compressed-air accumulators the rescue party may remain at work indefinitely if circumstances require. This is so immense an advantage for this form of respirator that M. Weiss, engineer of mines, strongly recommended its adoption in the French collieries at a conference held in 1906 before the Paris section of the Society for the Mineral Industry.

We must not leave a review of apparatus using ordinary air without referring to the Swiss respirator employing liquid air, still under experiment, but already put upon the market by the Hanseatische Apparate Bau Gesellschaft under the name of "aerolith." The apparatus is shown schematically in Figure 15. The principal part is the liquid-air reservoir e, which is carried upon the back of the rescuer. This is a rigid vessel of nickel steel, surrounded by many envelopes

FIG. 14. THE "AEROLITH" OR LIQUID-AIR RESPIRATOR IN SERVICE.

of corrugated paper-board, sheet metal, felt and leather. The liquid air is held in an absorbent material, asbestos being chosen to avoid the explosions which might possibly occur if organic absorbents were used. This air tank has in its upper part the charging opening a, provided with a screw stopper, and the tube b for the outflow of vaporized air. This air-supply tube b is intentionally made rather long so as to allow the air to become warmed to a certain extent and thus avoid discomfort to the user from breathing it at a very low temperature. It opens into a second flexible tube d, which serves also for exhalation and is of considerably larger diameter. This second tube carries at one end the mouth-piece. At the other it is attached to a metal pipe of 30 millimetres diameter, which runs diagonally across the liquid-air reservoir. The object of this arrangement is to facilitate the evaporation of the liquid air by the warmth of the respired gases. At its exit from the reservoir this transverse tube is connected to the retarding flask f, from which the vitiated atmosphere escapes through the orifice g, the rate of discharge being regulated at will. A little scraper, h, in the rigid tube allows this to be cleaned if it becomes obstructed by frost deposited within it. Like other types, the device is completed by a pince-nez. The apparatus weighs about 3.5 kilogrammes empty. It can hold about 6 kilogrammes of liquid air, say 10 kilogrammes total weight for the apparatus ready for use. This weight of air corresponds to about 4,800 litres and theoretically should suffice for about three-hours service. Figure 14 shows a rescuer equipped with an aerolith. As the liquid air is evaporated by the heat of that exhaled, the apparatus is self-regulating. The harder the work performed by the rescuer, the more active his respiration, the more rapid the circulation of

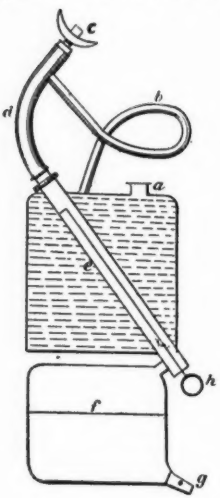


FIG. 15. SCHEMATIC SECTION OF THE "AEROLITH."

the warm "exhaust," and the greater the evolution of freshly-vaporized air. The top of the flask is provided with a little alarm clock, which may be set at will so as to warn the wearer when he has but a half-hour's supply remaining.

So far the aerolith has not been employed in French mines except experimentally. It has the disadvantage of necessitating the liquefaction of air, which is rather a costly operation, a machine with a capacity of 10 kilogrammes an hour being worth about 22,500 francs.

We may conclude with some consideration of the second great class of appliance—that of apparatus comprising pumps and piping, which is required for large work such, for instance, as the construction of earth or masonry dams. All such devices involve the same principle and consist of:

1.—First a compressed-air supply, of either pump or blower type;

2.—A helmet or similar respiratory appliance with which the worker is provided;

3.—The series of pipes through which the fresh air is supplied.

The latest of these systems commonly used in French collieries is the Fayol. Preference is sometimes given to the von Bremen apparatus, well known in Austria, or to that of Koenig, Stolz, Lieb, or Schraum, which are employed in a number of German establishments. The tube is usually of rubber, varying in diameter, reinforced with metallic windings. At the mines of Commentry it is incased in cylindrical iron boxes for transportation. The respiratory appliance may be a simple mouth-piece with pince-nez, (still employed) or a true diver's helmet with an impermeable seamless blouse, permitting the escape of the vitiated air as in the von Bremen and Koenig systems.

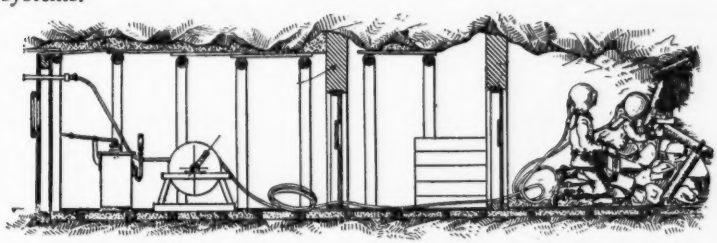


FIG. 16. SECTION OF A DRIFT SHOWING SALVAGE WORK WITH THE VON BREMEN APPARATUS.

Figure 16 represents the von Bremen apparatus in use in operations for the extinguishment of a mine fire. To begin with, the burning portion is isolated by tight barriers, to prevent the inflow of fresh air and consequent explosions which might make all salvage

work impossible. Following this, as rapidly as possible, new barriers are erected of planks or of earth enclosed between planks. These are provided with doors and as soon as one is completed a second is raised a short distance behind it, thus constituting an air lock. The pumps, hose reels, etc., are behind the air lock in the open. There, also, additional rescue apparatus is held ready for the relief of the rescue party. These latter, equipped with air helmets, enter the air lock, and after closing the outer doors pass through the inner barrier into the fire zone. The reserves may watch their movements through thick glass lights placed in the doors. If the tubing is sufficient for an advance of 100 metres, it may be seen that the work of clearing the gallery can without great danger be prosecuted for a certain distance. The rescuers, thanks to the apparatus they wear, may easily remain in an insupportable atmosphere and they have nothing to fear from explosions, all access of air having been rendered impossible. When their advance has been pushed a certain distance a new air lock is constructed and the old one behind may then be torn down. When they arrive close to the fire, the salvage party may erect permanent barriers of brick and completely enclose the fire. In some cases a single air lock is not considered sufficient and a double lock with a third door is provided as shown in the figure.

Such is the present state of the art in France. If the eminent director of the *Ecole des Mines* of Paris could formerly say, to the great astonishment of his hearers in a certain conference, that "we knew the number of the victims made by these appliances, but we might find difficulty in enumerating the persons whom they have saved," it may clearly be seen that any such assertion nowadays would find many to contradict it. No doubt in certain catastrophes all rescue is impossible, even with safety appliances. It is nevertheless true that at Courrières, for example, to cite but a single case of the many which might be advanced, the Paris firemen equipped with Vanginot respirators penetrated workings where the German miners from the "Hibernia," although much more skilled in underground work, did not dare to venture. Therefore, we may state confidently that with rescue stations above ground, with refuge chambers in dangerous workings, with simple and practical salvage appliances such as those described, kept constantly in good order, and finally with properly trained rescue corps, salvage work in the collieries would be greatly improved. In this manner we might diminish the effect of coal-gas explosions which sometimes flash like a subterranean lightning stroke through the galleries even of the best ventilated mines.

ON THE SIZE OF BATTLESHIPS.

By Sidney Graves Koon.

The active discussion of naval expenditures by the great nations on both sides of the Atlantic makes very opportune this analysis showing the great sacrifice in efficiency which must be made where the size of the battleship is reduced.—THE EDITORS.

MUCH has been written recently regarding large battleships and their great adaptability to uses where smaller ships could be employed only with large increase of numbers. In general the discussions have dealt almost wholly with the question of gun power, and have either ignored the physical relations between large and small ships, or have covered them by implication only. It is proposed to take up a representative battleship, such as the Michigan in the United States navy, and to institute a number of comparisons between this ship and two ships, each of half the displacement of the Michigan, but designed under varying conditions so far as the principal military features are concerned.

In the first place, a design might be evolved in which the various percentages of weight used for the several elements constituting the displacement of the Michigan might be retained in the smaller vessels. A second design would call for the same battery as the first, the same speed as the type ship (Michigan), and such armor protection as might be available after making due provision for these other two features. A third design calls for the same battery as the first, and for protection equal to that given the Michigan, with such speed as can be obtained in connection with this battery and armor. The fourth design calls for the same speed and protection as in the Michigan, and for such battery as may be obtained after making provision for the other two items.

While the weights allotted to the various component portions of the Michigan are not public property, and cannot, therefore, be given with any exactness, yet a sufficiently close approximation for our purpose can be made, and whatever errors there may be in this statement of weights will by no means vitiate the comparison instituted. A schedule of weights assumed for the Michigan is given on page 22. This accounts for the total displacement of 16,000 tons.

The Michigan has a length on the water line of 450 feet, a beam moulded of 80 feet, and a draft of 24 feet 6 inches. She is propelled by twin screws, the horse power of the machinery being designed as 16,500, and the designed speed, 18.5 knots. The battery consists of eight 12-inch guns mounted in pairs in four turrets on the center line, in such a way that all can be brought to bear on one broadside. The secondary battery includes twenty-two 3-inch and fourteen smaller guns, besides two torpedo tubes. The protection includes a water-line belt with a maximum thickness of 11 inches, upper belt with maximum thickness of 10 inches, turrets and barbettes with thickness of 8 to 12 inches, and a protective deck with a maximum thickness of 3 inches. The assumed schedule of weights is :—

Hull and fittings complete	6,400 tons
Equipment and stores	800 "
Battery and ammunition	1,300 "
Protective deck	900 "
Other armor	4,200 "
Machinery and water	1,500 "
Coal	900 "

The ratio between the length of one ship and the length of a ship of similar shape and half the displacement is 1 to 0.7937. Applying this ratio to the dimensions of the Michigan, we have for each of our smaller ships a length of 357 feet, a breadth of 63 feet 6 inches, and a draft of 19 feet 5 inches. Our first ship would have a schedule of weights each item of which would be just one-half the corresponding item for the Michigan, as shown in the table for weights under the four different designs. This ship would, of course, have just half the Michigan's battery, namely:—four 12-inch guns, eleven 3-inch, seven smaller, and one torpedo tube. Its armor protection would cover the same proportionate area as that of the Michigan, each linear dimension, however, being proportionate to the corresponding dimension on the Michigan, in the ratio above given. This same ratio would affect the thickness of the armor everywhere, and the 11-inch belt would become 8.73 inches thick; the upper belt would have a maximum thickness of 7.94 inches; the turret and barbette armor would vary from 6.36 to 9.54 inches; while the maximum thickness of the protective deck would be 2.38 inches, in place of the 3 inches in the Michigan.

Not only would the armor be thus decreased in value as compared with the Michigan, but the speed would also be decreased, due to the fact that it is physically relatively more economical to propel a large vessel than a small one. This fact may be brought out by analysing the expected speed performance of the Michigan by means of the Admiralty formula:—

$$V^3 = \frac{H \times K}{D^{\frac{2}{3}}},$$

where V is the speed in knots; H is the indicated horse power; D is the displacement in tons; and K is a coefficient of performance known as the Admiralty coefficient, and used for designing purposes. $D^{\frac{2}{3}}$ for the Michigan is 635; for each of the other vessels under consideration it would be 400; V^3 for the Michigan is 6,332; H for the Michigan is 16,500; K thus becomes 244. As the new ship has the same form as the Michigan, we may without sensible error assume that this same coefficient, 244, may here be used. On applying this to the formula, knowing that our horse power is 8,250, we find that V, or the speed, becomes 17.14 knots, in place of the Michigan's 18.5.

The second design calls for the same speed as the Michigan, namely 18.5 knots. In this case, by using our formula, we find that the horse power required is 10,380. This raises the weight necessary to be devoted to machinery from 750 tons to 944 tons. As the battery of this ship was to be unchanged, and the armor protection to be so adjusted as to fit the new conditions, the difference of 194 tons must be taken out of the provision for protective deck and armor, thus reducing these two items to 416 and 1,940 tons respectively. Assuming that each portion of the vessel is covered with armor of the same area as before, but of thickness reduced in the ratio of the weights allotted to armor, we find that the belt has been reduced from the original 11-inch maximum to 8.07 inches; the upper belt is reduced from a maximum of 10 inches to 7.34 inches; the turret barbette armor from 8 and 12 inches to 5.87 and 8.81 inches; and the protective deck from a maximum of 3 to 2.2 inches.

The third design uses the same armor schedule as in the Michigan, both as regards actual thickness and proportion of ship protected. This results in increasing the weight required for protective deck from 450 tons, under design 1, to 567 tons, and for the other armor from 2,100 tons, under design 1, to 2,646 tons. This total increase of 663 tons is made at the expense of the propelling machinery, the weight allotted to which thus becomes reduced to 87 tons. This accounts for only 957 horse power, or a speed, from our formula, of only 8.35 knots. This shows what a very great diminution of speed must be expected if we are to retain in the smaller ship the same relative battery power and protection as in the larger.

The fourth design calls for the same speed and armor protection as in the Michigan, and the difference in weight is taken from that allotted to the battery. As found in the second design, the required

horse power is 10,380, calling for 944 tons of machinery. The armor weights will be the same as in the third design, namely, 567 tons for the protective deck, and 2,646 tons for the other armor. As we have made no change, throughout the series of designs, in weights of hull and fittings, equipment and stores, and fuel, we still have for these items a total of 4,050 tons. Adding this to the above-mentioned figures for machinery and protection, the total becomes 8,207 tons, or 207 tons more than the designed displacement of the vessel. This means that in order to float at the designed displacement with the same structure and equipment, an amount equal to 207 tons would have to be taken bodily from the vessel, or stores, or both, and it means, moreover, that there would be absolutely not one pound available for the provision of a battery of either heavy or light guns. Of course it will be recognized that we have appropriated all the necessary weight for a splendid protection to such a battery, and that no designs would ever be evolved in which such protection would be provided without allowing for the battery itself. These figures have been worked out, however, simply for the purpose of showing the immense sacrifices which have to be made in various directions in small vessels, in order to provide along other lines qualities similar to those obtained in vessels of larger size.

Item.	Type 1.	Type 2.	Type 3.	Type 4.
Hull and fittings.....	3,200	3,200	3,200	3,200
Equipment and stores...	400	400	400	400
Battery and ammunition.	650	650	650	—207
Protective deck	450	416	567	567
Other armor	2,100	1,940	2,646	2,646
Machinery and water....	750	944	87	944
Fuel	450	450	450	*450

The figures above deduced show that under a given set of conditions the two small vessels having the same total battery power as the one large would require these sacrifices to be made along other lines:—

If there is the same proportionate weight for armor, there will be a sacrifice in the thickness of armor amounting to nearly 21 per cent; there will be a sacrifice in the speed amounting to about 8 per cent. If the total battery power is to be the same, and the speed is also to be equal to that of the large vessel, there will be sacrifices in the armor protection, the reduction in thickness being about 27 per cent. If the total battery is to be the same, and the armor protection equal to that of the large vessel, the sacrifice in speed will be tremendous—in fact, markedly greather than would ever be permitted in any design. The falling off would be more than 10 knots; that is, about 55 per cent. If we have the same speed and the same protec-

* Reduced to 243 on account of deficiency for weight of battery.

tion for the two smaller ships that we have in the larger, there will be no weight available for battery, and our fuel supply will be cut off more than 45 per cent.

This line of reasoning shows that there are other reasons besides those of mere gun fire which militate in favor of large ships as compared with small ones. If it were a question of gun fire alone, we might consider that a ship similar in design to the original monitor might be the ideal; for a fleet of such ships could bring all their guns to bear at any point of the compass, because the monitor had a practically unobstructed range of fire all around the horizon. As ships increased in size, demands came for a larger armament, and double-turreted monitors were the answer to the demand. The Michigan is the next in this direct line of development, although there have been many, many changes between. The double-turreted monitor design has had added to it a battery of broadside guns, only one-half of which in general could be brought to bear upon one broadside at a time. In the Michigan, however, we have gone back in general principle to the double-turreted monitor, carried one step further, for each of the four turrets has command over about three-fourths of the horizon. The small ships represented in the above figures would naturally be provided with two turrets each, instead of the four in the Michigan, and would have the same relative command of fire as in the latter ship. Whatever other battery is fitted in accordance with the above figures would be solely for the purpose of discouraging torpedo boats from too much inquisitiveness, and does not affect the general type evolved.

It has long been recognized that every man-of-war represents a compromise between conflicting military interests, and the science of naval architecture has not yet developed an ideal relationship between these interests, nor will it probably ever be reached. For some reasons, speed is an almost paramount consideration, while for other purposes the one item of prime importance is battery power. In either case a certain amount of the one must be associated with the other; for the speed is of no avail unless the battery be at hand to back it up, and the battery is of slight value unless the speed be sufficient to place it within reach of the enemy. Protection and battery go largely hand in hand, an increase in the latter calling usually for a corresponding increase in the former. This is not the case in extreme types, but it is a general principle. In all ships, however, certain sacrifices of one element have to be made to meet demands for excessive provision in another, and in no ship is this sacrifice more marked than in that of small size.

A COMPLETE SYSTEM FOR THE PURCHASING DEPARTMENT.

By J. Cecil Nuckols.

THE purchase of raw materials which enter into the manufacture of the finished product constitutes a very vital element of any factory, and it requires knowledge that comes only from a close study of one's business.

Let us first inquire closely into just what we term the "purchasing department." In most concerns the buying is looked after by one who knows thoroughly that important branch of the business, and even in small partnerships one of the partners usually assumes the duties of the purchasing agent. So then, in this article, we will deal with the purchasing agent and his records—records that are necessary to intelligent buying.

We shall not discuss the qualities that should be possessed by the successful purchasing agent. A man may be gifted with a fund of general knowledge, may possess all the qualities that tend to make a successful buyer, but without system his department can never become ideal. But, on the other hand, some of our most successful purchasing agents may have no particular qualifications save common sense, and yet their departments are models because they are systematic. They are enabled to buy right, from the right sources, and at right prices.

Vital Information.

A purchasing department may be conducted satisfactorily only by having certain information instantly available. The purchasing agent must be fully informed as to all dealers supplying the classes of goods he must buy. He must know what dealers are most favorably located as to transportation facilities. But this must not overshadow the fact that sometimes dealers at a more distant point will make certain concessions which make it obviously wise to buy from them. The purchasing agent can often, by buying far enough ahead of immediate requirements, find an opportunity of saving quite a considerable sum.

To classify properly the information about the goods supplied by the dealer, he must file and index all catalogues and other litera-

Firm: The S. Obermayer Co., Cinti., O.

Subject	File	Catalogue	Page
Plumbago	47	#40	34

The Eng. Magazine

FORM 1. INDEX CARD FOR CATALOGUE—BY FIRM NAME.

ture which will give the desired data. A catalogue file with adjustable partitions will be found the most practical, and all catalogues should be cross-indexed as shown on Forms 1 and 2. Form 1 shows

Subject: Plumbago

Name	File	Catalogue	Page
S. Obermayer Co., Cinti.	47	#40	34

The Eng. Magazine

FORM 2. INDEX CARD FOR CATALOGUE—BY PRODUCT.

the card for the name of the dealer. These should, of course, be filed alphabetically, and I would suggest that they be blue. On this card is space for the dealer's name and address and the various goods he supplies. The file column refers to the compartment in the catalogue file, and there are also columns for the catalogue number and the page where the desired information may be found. Form 2 should be a white card and should be filed, also alphabetically, according to subjects.

Article Plumbago

Date	Firm Name	Address	Price	F.O.B.	Cat'g	Ord.
1/25/08	S. Obermayer Co.	Cinti.	5¢ lb.	Cinti	#40	1/29

The Eng. Magazine

FORM 3. INDEX CARD FOR QUOTATIONS.

The purchasing agent should never place an order without full information as to prices charged, etc., but often time will not permit writing for prices before the order is placed. He should have completely classified records of all quotations previously received and Form 3 will answer this purpose nicely. Not only must he get the right prices but he should know just what quality of goods may be expected from the various dealers. Of course all contracts permit the refusing of goods which do not come up to specifications, but this may mean a great loss where the materials are needed immediately. It often happens that the question of delivery is as important as the question of price. A dealer may have goods satisfactory in every way, and still be so slow in making delivery that the loss of time more than offsets any price consideration. He finds it necessary, then, to have full information about the manner in which orders are apt to be

filled. On Form 3 should be entered a synopsis of each quotation received, the prices named by different concerns being seen at a glance. When the spaces on one card are filled, another is added. All quotations being entered in the order of their dates, the last card always shows current prices. These quotations should be filed under the names of the articles.

Requisitions.

Not only is information on which to buy right important, but to keep a proper record of purchases is of equal importance. The purchasing agent should be able to tell instantly when an order was placed, where it was placed, why it was placed, and when he may expect delivery. This does not mean a mass of records, for proper system makes it a very simple matter, and one easily provided.

Requisition
Original

Dept._____ Date_____

No._____

Mr._____ P.A.

You will please furnish this department as soon as possible with the following:

_____
Dept. Head

Quantity	Articles	Purpose

Ordered_____ From_____

The Eng. Magazine

FORM 4. REQUISITION BLANK.

He should demand a requisition before the order is placed, showing by whom and in what department the goods are wanted. He naturally will receive requisitions from the following sources:—From the stock department for goods to be placed in stock. From the order department for goods with which to fill orders. And from the various department heads for articles required in their particular departments. Form 4 shows a simple requisition blank. Different colors for the different departments will be found the best plan, as a glance will show from which department it comes. Each requisition

ORDER

The S. Obermayer Co.

Order No. 2293
Requisition No. 1924

Cincinnati_____19_____

To_____

_____

Please ship via_____ to us at_____

the following as per your quotation of_____

Important

Our order and requisition numbers must appear on bill.

Date Wanted

The S. Obermayer Co.

_____
Purchasing Agent

Tear this off and mail promptly to

Order No. 2293
Req. No. 1924

The S. Obermayer Co., Cincinnati, Ohio

Gentlemen: We expect to ship_____

Signed_____

The Eng. Magazine

FORM 5. PURCHASE ORDER.

should give full information as to size, etc., and should be either signed or O. K'd by the department head.

When the goods have been ordered, the date and the name of the concern from whom ordered should be entered on the requisition. It is then ready for filing. It will be found most practical to file all requisitions according to departments, keeping them according to dates. A card-index drawer about 5 inches by 8 inches will be found an admirable size and place in which to file these requisitions. The indexing of these is a very simple matter. Take a set of blank guide cards, one set for each department, write the names of the different departments on the projections, and you have all the index you need. Should a larger blank than a 5 inch by 8 inch be required, file these in a vertical correspondence file.

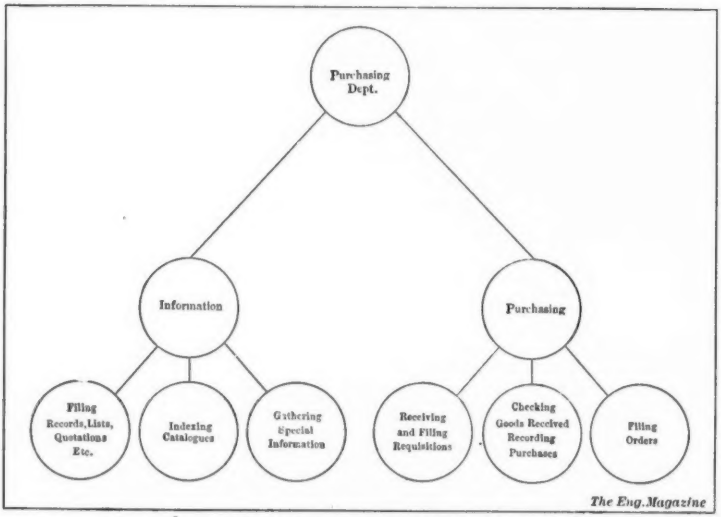
Purchase Orders.

In Form 5 is shown an order form which will answer for the average concern. This, of course, may be easily modified, but under most conditions it will answer the purpose as well as a more elaborate one.

It is, of course, necessary to keep a copy of all orders placed. As many copies as may be required may be made at one operation by using carbon paper and the typewriter, billing-machine, or by hand. In a small business one copy is sufficient, while in larger concerns as many as five or six may be necessary, depending upon the nature of the business. Ordinarily orders in triplicate will answer—the original to be sent to the concern from which the material is ordered, one copy for the purchasing agent, the third for the receiving clerk. On this latter it is not advisable to show prices. This can be provided by using a short carbon over this copy, thus leaving all blanks of uniform size. In larger concerns the purchasing agent has no direct connection with the auditing department, and here we need another copy of the order that all bills may be properly audited. Then, too, the head of the concern should also have a copy of the order that he may know in advance what obligations are being contracted.

Let us trace the disposition of each copy of the order, supposing that five copies are made.

The original is signed by the purchasing agent and mailed to the concern that is to fill the order; a copy is retained by the purchasing agent for his files; one copy is sent to the receiving clerk to be filed under the name of the firm, so that when the goods are received the order may be easily referred to for checking purposes; another copy goes to the manager for purposes stated above; and the other copy to the auditing department.



FORM 6. ORGANIZATION OF PURCHASING DEPARTMENT.

When the goods are received the receiving clerk checks the items with his copy of the order, and then returns this to the purchasing agent so that he may know that the goods have been received. The purchasing agent's copy should be used by him to follow-up the shipper. The order should be placed in a file provided with indexes (numbered one to thirty-one) under the date when an acknowledgement may be expected. Should no acknowledgement be received a letter should be sent to find out if the order has been received. Ordinarily the acknowledgement will give about the date when the goods will be shipped. Then the order should be filed ahead under the date when the invoice should be received. In this way you provide for another follow-up if no invoice is received, and even after date of shipment the order may be still placed ahead to follow-up the transportation company. After the goods are received the copy of the order in the office file should be attached to the original requisition and filed under the name of the concern. Fig. 6 shows an organization chart of the purchasing department, and a careful study of the system outlined will show that all of these records are kept with a minimum of time and labor.

Leschen Rope Tramway for San Toy Mine, Chihuahua; 4,600 feet long.

HOISTING MACHINERY FOR THE HANDLING OF MATERIALS.

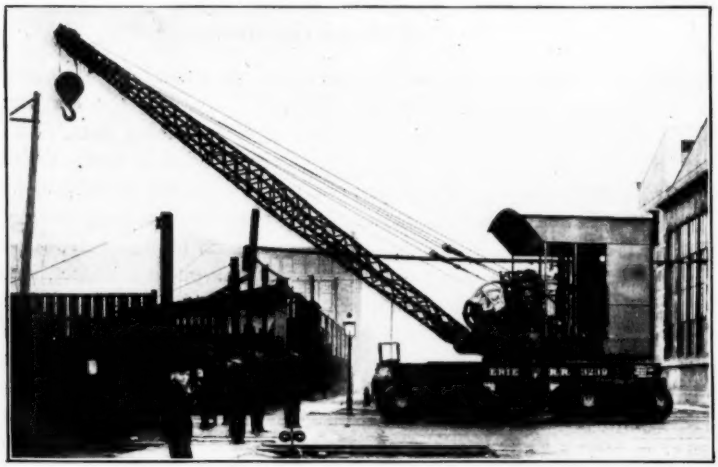
By T. Kennard Thorn.on.

STATIONARY cranes are restricted in their usefulness to such work as can be completed within their reach—for instance, feeding a punching machine, loading or unloading cars, boats, etc; but they would not be economical where a series of cranes would be required to pass an object from one end of the shop or yard to the other. It is a well-known maxim that it costs money every time an object is picked up, even if it is put down again immediately, for it always takes more or less valuable time to hook on to a bucket, steel plate, or other piece and to unhook again. Even lifting an object at one end of a shop and placing it on a flat car to be pushed or pulled to the other end of the shop or yard and there unloaded may not secure the best economy, so we have the movable cranes such as the gantry, overhead three-motor electric traveling cranes, locomotive cranes, etc.

The locomotive crane, though invaluable in many places, is more useful where the range of work is limited but progressive in location, such as building long masonry walls, excavating canals, loading coal, or, in other words, wherever considerable work can be done between each move of the machine itself, or where the object to be picked up and held suspended while the crane moves is only to be handled occasionally and the expense of a bridge crane would not be justified. A locomotive crane was originally a pillar crane put on a truck and capable of propelling itself. As now built, however, the pillar feature has almost entirely disappeared. As the number of uses it can be put to are unlimited, so the variations of boom length, capacity, and design are legion; all, however, have a truck usually to run on a standard-gauge track until the load to be lifted exceeds about 20 tons. The truck carries the turn table with the boom and mechanism, the engine, boiler, and sometimes an additional load to act as a counter-

weight to prevent the crane from overturning. Vertical engines are found better for 10-ton cranes than horizontal, causing less vibration, sometimes a very important consideration. Two engines coupled at right angles facilitate the starting and equalize the power.

The same pair of engines usually lift the load, rotate the upper part of the crane, and at the same time, if necessary, propel the crane itself, the latter motion being usually obtained by means of bevel gears connected with the shafts of all four wheels, so that if the load is unbalanced, that is, throwing a greater weight on some of the truck wheels than the others, the motion will not be interrupted.

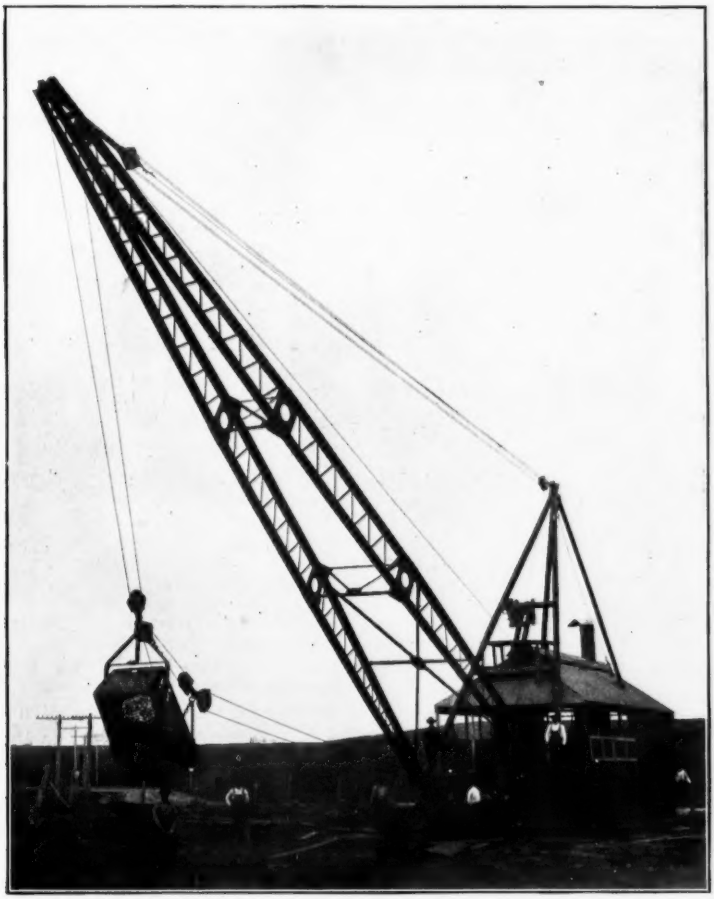


LOCOMOTIVE CRANE, 20-TON, 8-WHEEL M. C. B. TRUCK.

Brown Hoisting Machinery Co.

The boom lowering is sometimes accomplished by means of worm gearing of such pitch and lead that the wheel, of hard bronze, will not drive the worm, of tooth steel, thus holding the load in position, and, in addition, the worm shaft is locked by special means when it is wished to hold the boom in its position; if extra heavy weights are to be lifted without moving the crane itself, clamps are provided to hold it to the track. A 5-ton locomotive crane with a 30-foot boom costs about $4,000, while a 10-ton crane with same boom length is worth about $5,500.

When extra heavy loads are to be lifted with a long boom, a travelling derrick is generally substituted, having a fixed frame of wood or steel on a truck, which allows the boom to revolve by itself. The truck runs on a gauge anywhere from 10 to 30 feet.



STEEL REVOLVING-BOOM EXCAVATOR READY FOR WORK, BATON ROUGE, LA.

Weighs about 50 tons, and operates a 2 cu. yd. bucket by an 80-ft. boom. Is designed to fill, empty, and return the bucket in 60 seconds. Cost, erected in place, nearly $9,000. Installed by Page & Schnable.

The cut above shows a good example of a powerful revolving derrick with an 80-foot boom with an excavating bucket, like a plough shovel, which is lowered from the end of the boom, and then scrapes up the dirt by being drawn towards the derrick by means of the hoisting engine; when filled, the bucket can be hoisted while the derrick revolves so as to dump the load where desired.

Locomotive cranes or traveling derricks are not best adapted

for quick transfers covering considerable distance, being slow and cumbersome and tending to interrupt workmen while passing; so where swift, long, and unimpeded movement is necessary they make way for the gantry and bridge traveling cranes.

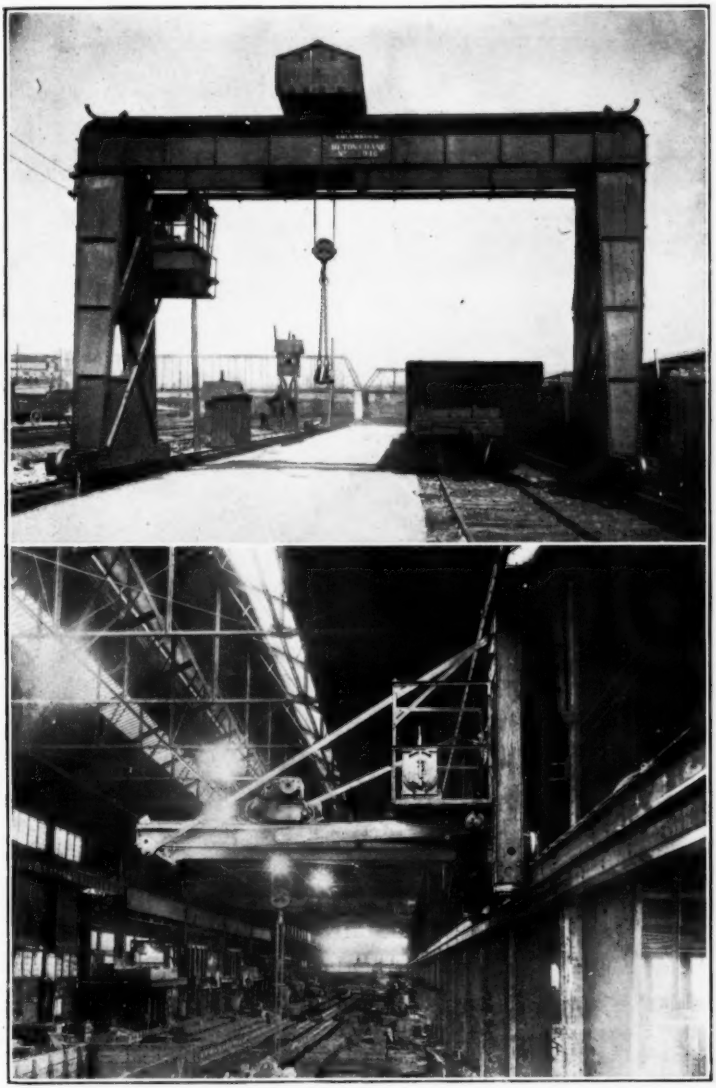
LOCOMOTIVE CRANE FOR BOILER-HOUSE COAL-HANDLING SYSTEM, PUBLIC SERVICE CORPORATION OF NEW JERSEY.

Unloads from barges and stores 10,000 tons on wharf; discharges into wide-trough chain conveyor leading to boiler house. R. H. Beaumont & Co.

Gantry cranes are very useful in freight yards and like structures where it is not advisable to raise the track and runway to the level of the bridge, doing away with the legs; but where this can be done we have the three-motor electric traveling cranes now so familiar in stone yards and all manufacturing concerns where heavy loads have to be handled quickly. These bridges can be built to span almost anything, from 10 feet up to several hundred feet, though there are very few of over 200 or 250-feet span on account of the great cost; in the case of a big dam or other structure, however, the expense is justified.

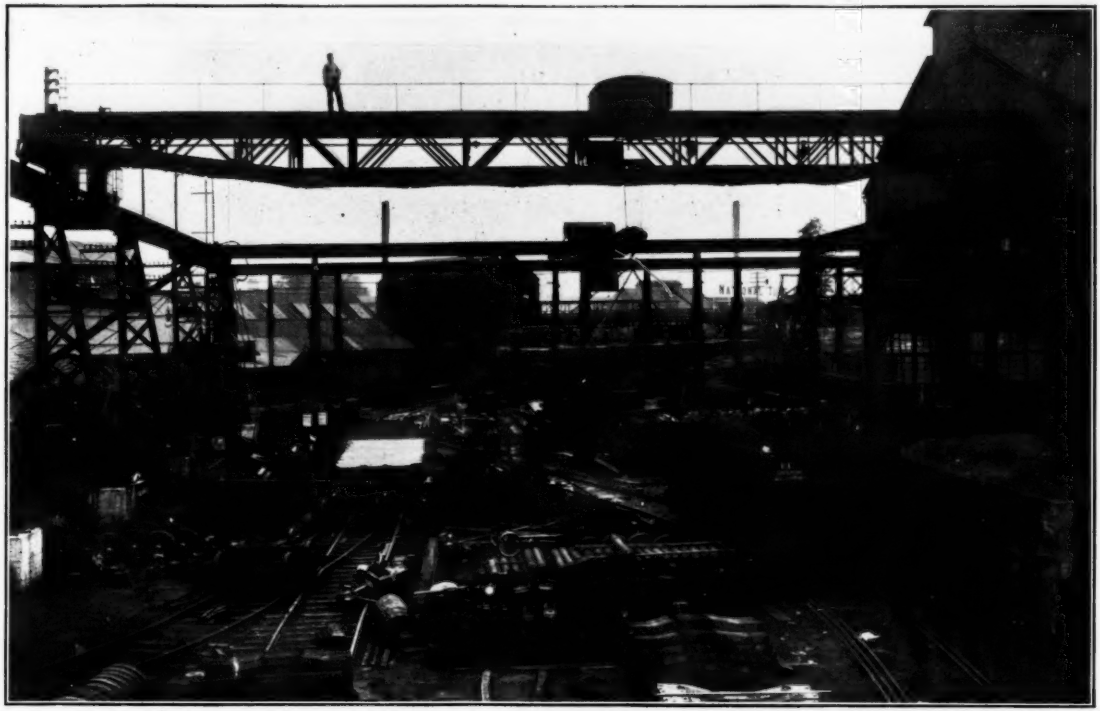
Obviously the legs of a gantry make it cost more than a plain bridge of the same capacity if the cost of the runway is disregarded, so if a number of machines were required in the same yard the increased cost would often be enough to pay for the elevated runway.

Gantries are rarely used in shops except for carrying heavy riveting or punching machines, or similar tools, as the walls of the shop afford such a good purchase for the runways; these are usually



EXAMPLES OF MODERN AMERICAN TRAVELING CRANES.

Above is a 10-ton gantry for unloading cars, C. M. & St. P. Ry., Chicago. Below is a 5-ton wall crane for the Buckeye Steel Castings Co. Both installed by the Case Mfg. Co.



ALTERNATING-CURRENT CRANE, 15-TONS CAPACITY, FOR OUTDOOR SERVICE

At the Middletown Car Company's plant. Span 105 ft.; runs on steel elevated runways supported on A-frame posts; latticed bridge-girder construction was adopted to reduce wind pressure and keep down weight. "Northern" type trolley, covered; operators' cab enclosed. Northern Engineering Works.

TWO LOCOMOTIVE CRANES WITH GRAB BUCKETS, UNLOADING COAL FROM BARGES TO STORAGE.
Browning Engineering Co.

built as near the roof as possible to give the maximum clearance for work. In the yard the track is usually placed from 15 to 25 feet above the ground. The trucks running on these rails usually have two wheels each and are rigidly connected with the traveling bridge. The bridge itself, being made in at least two parts, carries a powerfully built trolley or truck running at right angles to the bridge runway, thus moving with or without its load from one side of the shop or yard to the other, and, at the same time, the bridge can move from one end to the other—hence the name "three-motor electric traveling crane"—the motions being vertical, sideways and lengthways—and all these motions can be carried on simultaneously and without disturbing the workmen below, whereas if booms were swinging around all the men anywhere near would stop work to keep an eye out for danger, having learnt the necessity by experience.

The number, capacity, speed, etc., of the cranes are limited only by questions of economy; they can be designed to lift anything from a crowbar to a giant locomotive from any one corner of a shop and put it down in any other, with a bridge speed of say 200 feet per minute.

As in the early days of iron bridge building (not over forty years ago), when traveling cranes were first introduced into the United States, several firms started to make their own independent

designs on entirely different lines, so that when I first became designing engineer for a crane company, some fifteen years ago, a very casual glance was sufficient to tell who built the bridge crane, and each company had its own pet style which it tried to work in, in every and all places, whether it was the best or not. Now, however, the best features of all are used where they are most fitted. While steam is still the best power for locomotive cranes under most conditions, electricity is the power for bridge cranes and is sometimes also used for the locomotive crane in the yard.

It was quite a problem to decide the best way to keep the traveling bridge at right angles to the track, or to prevent one end of the bridge from getting ahead of the other. Some of the early efforts resulted in an endless chain or cable so attached that the bridge was held in its correct position. It can easily be realized what an objectionable makeshift this was.

Another problem was to decide just how much side strain would be thrown on the girders from the tendency of one truck to get ahead of the other, and from the sudden starting and stopping which always tend to jerk the ends of the bridge out of the line of the center, causing the whole bridge to deflect sideways and increasing the compression in the top flanges above that already due to the dead weight of the crane and its supported load. Where, as in early days, the bridge is propelled by cog wheels on a track, there is no longer any trouble caused by one end getting ahead of the other; we still have always the horizontal deflection of the main girders to take care of.

It would seem that, if the Quebec bridge had been designed with the same regard for the theory of the column that crane engineers have always been obliged to use, that ill-fated bridge would be standing yet.

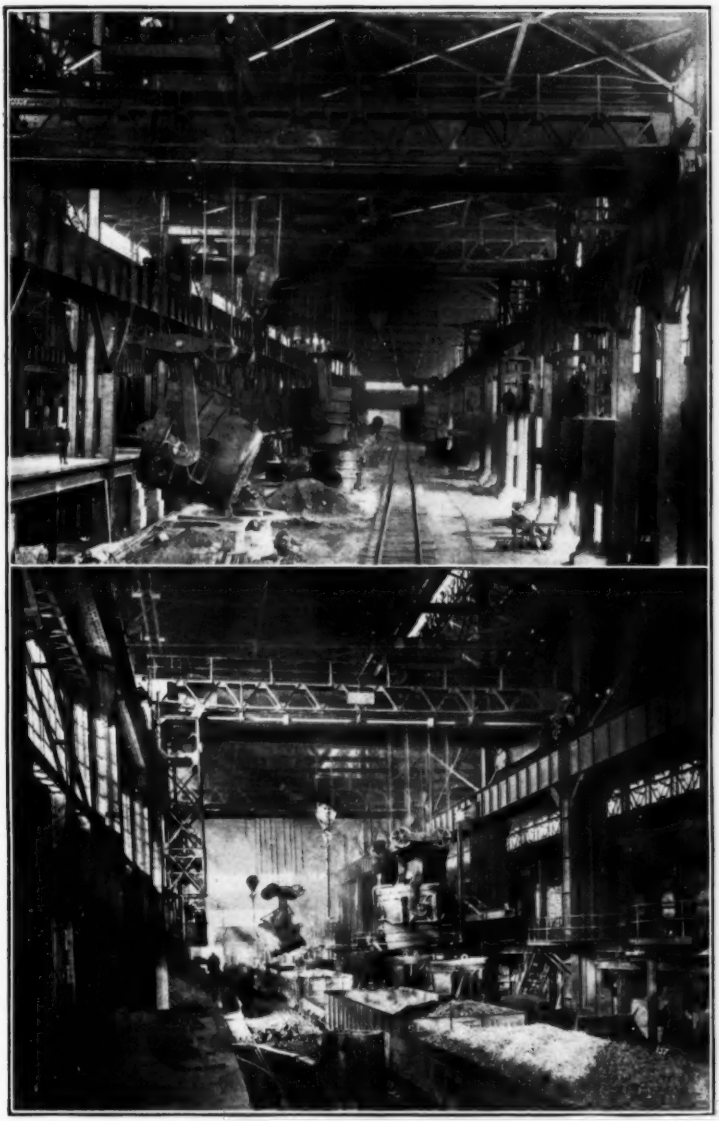
There are five distinct classes of bridge cranes:

1.—Those made of two I-beams carrying the trolley rail on the top flanges and good for short spans only. The spans, however, can be much increased by the new beam shapes being introduced by the Bethlehem Steel Co.

2.—Two ordinary plate girders placed from 2 to 6 feet apart, each carrying a trolley rail on top.

3.—Two box girders, each carrying two rails on top or four rails in all.

4.—Two plate girders placed several feet apart with their top flanges firmly braced together. In this case, the trolley rails are carried on the bottom flange or on a shelf angle bolted on the web near



HEAVY LADLE CRANES IN AMERICAN STEEL WORKS.

All are of 100-tons capacity with 25-ton auxiliary. The upper plant is the Union Steel Co., Donora, now part of the Carnegie Steel Co.; span 59 ft. 8 in., lift of main hoist 27 ft. and of auxiliary 31 ft. The lower is at the Illinois Steel Co. and is of 55 ft. span. Such an instalation is worth $29,000 to $25,000. The Wellman-Seaver-Morgan Co.

NILES CRANE, 20 TONS, 80-FOOT SPAN, WITH 5-TON AUXILIARY HOIST. RUTLAND FLORENCE MARBLE CO., FOWLER, VT.

the bottom flange, the whole trolley mechanism being inside the main girders instead of on top as in all the other cases.

5.—Two plate girders braced separately by three auxiliary lattice girders (six lattice girders in all), the eight girders forming two box girders. Here the trolley rail rests on top of the main plate girders.

There are many modifications but these five are the principal types. It was found advisable, in order to avoid complicated gearing and to make it simpler for the operator, to have a separate motor for each motion, one for lifting, one for trolley travel and one bridge travel; hence, the name three-motor electric traveling cranes.

There are places where none of the previously described machines is the best adapted for the purpose in view; such, for example, as bringing coal down the sides of a mountain, or mahogany logs to the coast, over very rough ground where a railroad would not be feasible. In this case the cableway often serves. Sometimes, as we most often see it in the city, all the work is done between two towers, and at others the cable is continued over a number of steel towers. For instance, cableways over 12 miles long have been supplied for South America, for handling mahogany logs which were cut in short lengths and bunched together before being attached to the carrying cable. As an example of how the location controls minor details of design—in this case, the towers all had iron ladders with very thin plates instead of round rungs, so that the bare-foot natives would not climb up and damage the cable or get killed by a passing load.

The first wire-rope tramway in America was introduced by John A. Roebling, of Brooklyn Bridge fame, who used a single endless wire rope ⅝-inch diameter passing around horizontal sheaves, one of which was driven by horse power. Now, however, as most have observed, we have a main stationary cable on which runs the trolley carrying the bucket or chain. This requires additional cables for raising the load from the ground and pulling the trolley back and forth, all of which have required many ingenious contrivances for taking up the slack.

With a single-span cable, the limit, of course, is the number of return trips that can be made an hour, for two cars can not pass on the same track; but on long cable tramways like the 12-mile one referred to, where all the heavy work is in one direction, it is possible to keep on attaching loads and thus have a continual series of loads moving all the time, a lighter cable carrying back the empty trolleys.

As a good example of the use of a cableway, we once put up a 1,600-foot span, 2-inch diameter cable, having a sag in the middle of

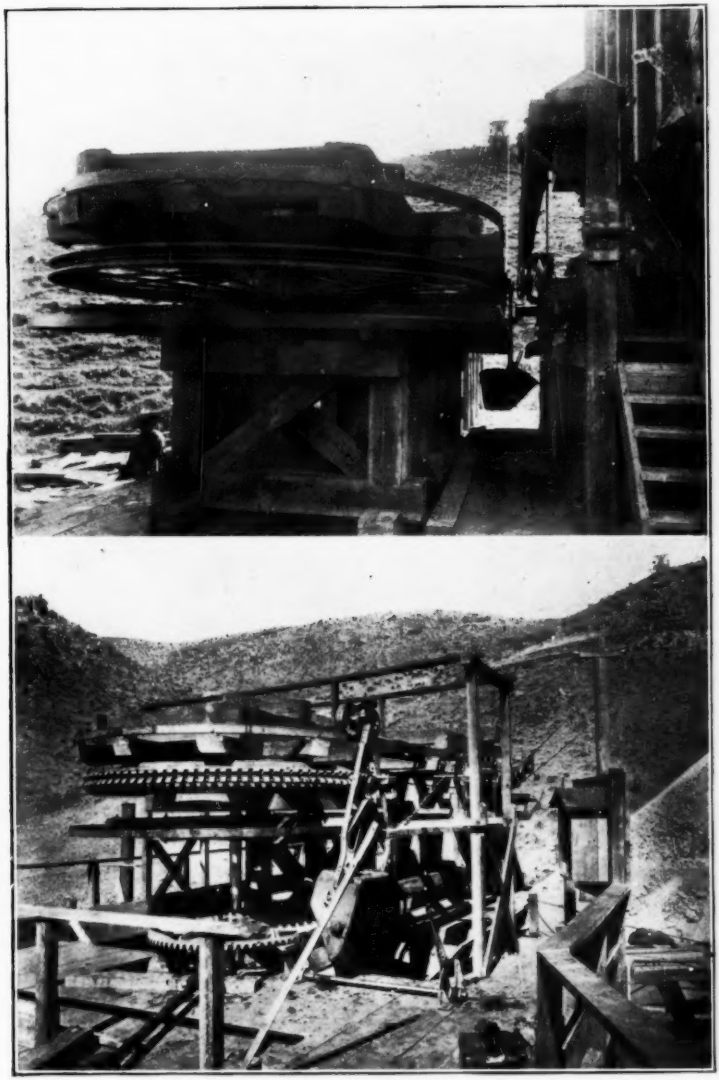
the curve of 90 feet, on two 100-foot towers, and erected the cables which we had in stock. This spanned a river in which we had some piers to build; we estimated that it would cost about the same to erect a light wooden trestle, but it was thought safer to keep out of the river, which view was justified by events, for before the piers were completed, we experienced a very severe flood which would have carried away any trestle we could have put in.

On the other hand, to show how a good plant could be put in the wrong place, a contractor, successful *in other lines,* took a contract for some heavy masonry work with which he was not at all familiar, and at once ordered five complete cableways, to be placed side by side, having a span of over 1,500 feet and carried on two 90-foot towers. When the first cable was ready for use, he decided to have a grand ceremony at the setting of the first stone. The immense stone was easily picked up by the cable and brought to the right spot and carefully lowered on its bed of mortar, but, as it nearly always happens, it did not land in just exactly the right position, so the operator was signalled to raise it. At first the cable refused to budge the stone, the weight of the stone plus the suction of the mortar causing more resistance than the weight of the stone by itself, so the operator applied more power and "up she came" with a jerk as soon as the suction was overcome; naturally, the upward bound was followed by a downward plunge, which splashed mortar all over the guests, and the contractor who had got what he had ordered wanted the whole apparatus taken off of the premises. The job put him out of business. and his successor made good use of the cableway, but not for setting stones.

The cable can be used almost anywhere, so it is often only a question of dollars and cents and time whether to use it or a railroad track and derricks; but in cases like passing coal from one vessel to another at sea and many similar operations the cableway has no competitor.

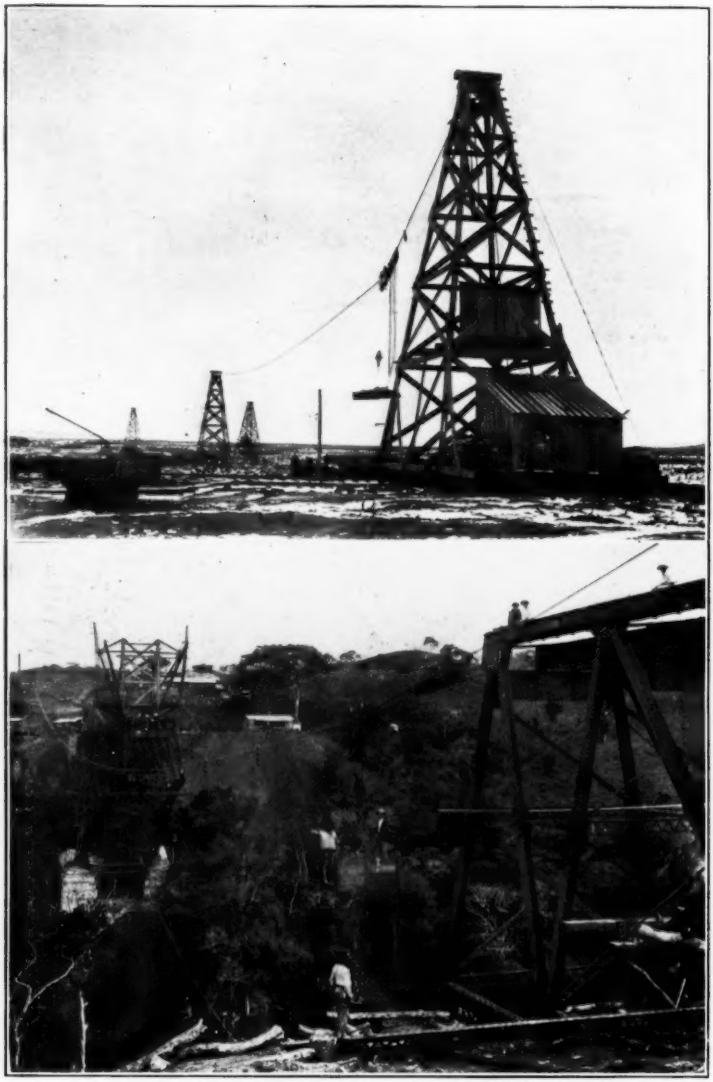
An ingenious arrangement is the balanced cableway in which the two ends of the cable are attached to movable weights just heavy enough for the greatest load to be lifted, instead of making the ends fast to a rigid anchorage. At the first glance it looks very insecure (see view of boat being carried over the waves at Coney Island); but as a matter of fact, it has many advantages over fixed anchorages, as it reduces the strain on the cable and does away with much of the sharp incline of the cable near the towers, up which the trolley has to be pulled at the cost of extra power.

One of the most recent cableways has just been completed for the



LOADING AND DISCHARGE TERMINALS OF 4,000-FOOT AUTOMATIC ROPE TRAMWAY, SAN TOY MINES, CHIHUAHUA, MEXICO.

Two Leschen flattened-strand track ropes supported on two towers are used, one for travel of loaded buckets and one for return of empties. The buckets, holding about 900 lb. of are each, are permanently attached by four band clips, preventing all slippage. They are loaded by a mechanical loader (shown above) and automatically discharged. The tramway is driven by power at the discharge terminal, as shown below, gravity being insufficient. Tension is applied at the loading terminal. Capacity 300 tons per day of 10 hours. The A. Leschen & Sons Rope Co.



CABLEWAYS IN SERVICE ON CONSTRUCTION WORK.

Above is a pair of cableways across Snake River, Minidoka, Idaho, for use in Government irrigation project. Below is a cableway used in Costa Rica in building a railroad bridge across a cañon 900 ft. wide and 300 ft. deep. The S. Flory Mfg. Co.

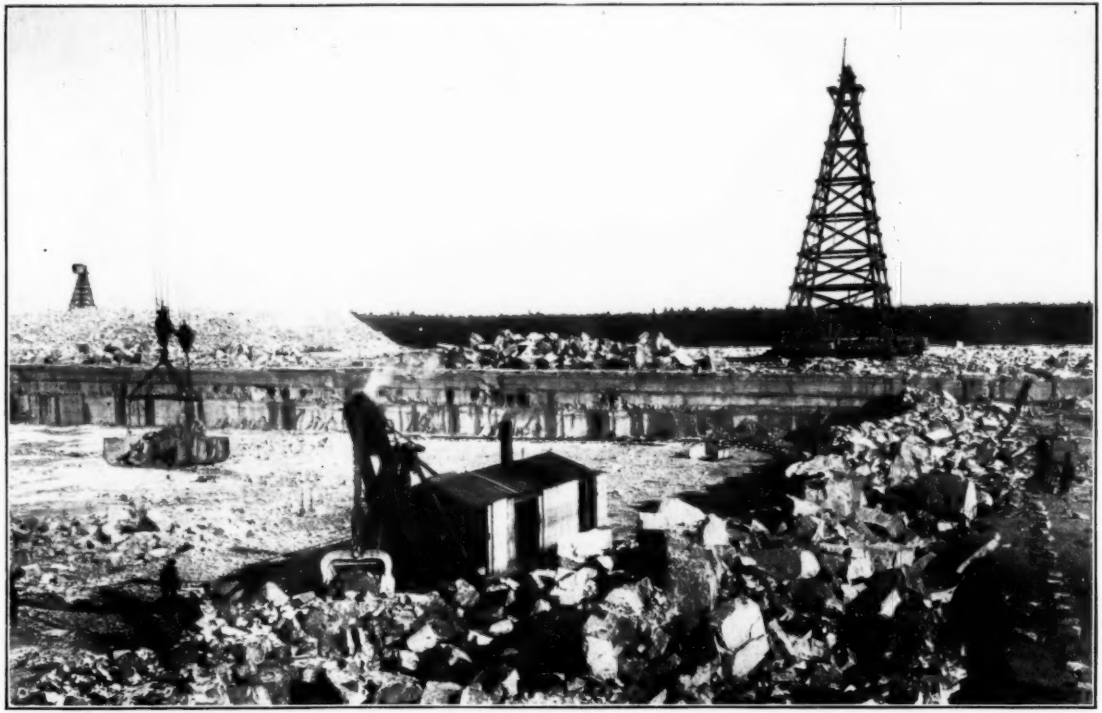
Geo. W. Jackson Company of Chicago to take supplies to a tunnel shaft 8,000 feet out in Lake Michigan. This is on the Elberfeld-Barmen system of Germany, and is supported by 26 towers 30 feet high, resting on steel piles. The carrying cable is 1⅜ inches diameter, while the transmission cable is ⅞ inch in diameter. The construction costs about $75,000, and the capacity is about 40 cubic yards of material per hour, requiring 15 horse power for operation.

EXPERIMENTAL BALANCED CABLEWAY AT CONEY ISLAND, N. Y.

About 800 ft. span; shears 103 ft. high; water 15 ft. deep.

A novel use for the cable was recently developed by the Williams Bros. & Morse Company of Cleveland in making a 175,000 cubic-yard fill for the Lake Erie and Pittsburgh Railway. The fill was 400 feet long and 95 feet deep. A light wooden tower was built in the middle, making the cable spans of 200 feet each. Two cables of 2¼-inch diameter were used and were spaced 7 feet apart horizontally. On top of the cables, 8-foot logs were laid and fastened with U bolts. These carried a pair of stringers which, in turn, supported the ties on which the rails were laid. The train of cars was backed out to this suspension bridge and the first car dumped as soon as it reached the edge of the fill and it was then pushed out on the cableway to permit the next car to be dumped and so on.

Light wooden bents were placed on the bank near the top of the slope to stiffen up the cable under the loaded cars. The following is



LIDGERWOOD CABLEWAY AND MARION STEAM SHOVEL IN ROCK EXCAVATION, ST. MARY'S RIVER IMPROVEMENT.

Trenton locked-wire main cable, spans 800 and 1,100 ft.; 65-ton shovel with 2½-yd dipper loading skips 2 by 2 by 10 ft.; average skip load 27 cu. yd. Record for month, 155 skips per 10-hour day.

the actual cost given by Mr. J. D. Mooney in a recent number of *Engineering Contracting* and is interesting:

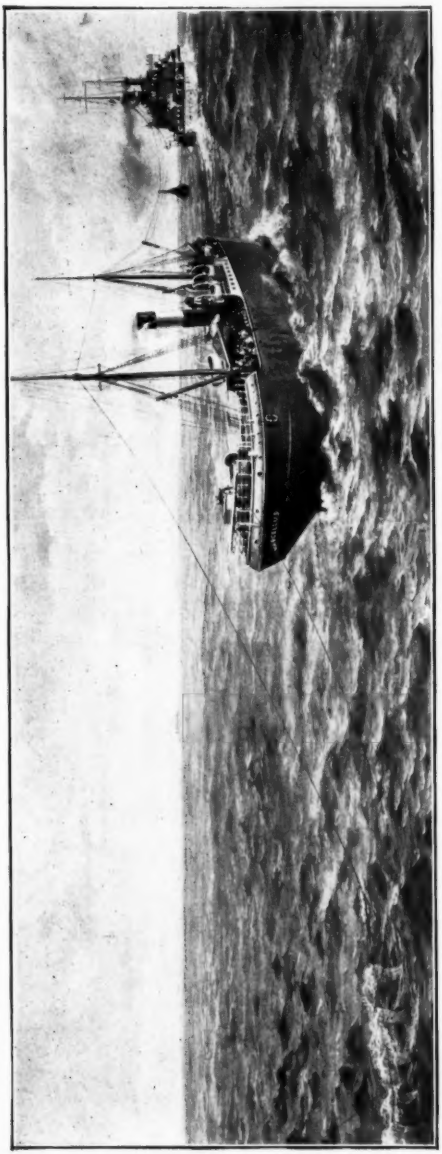
1,000 feet 2¼ inch Roebling galvanized bridge cable.....	$600.00
Eye bolts, 2½ inches.....	108.30
2 turn buckles, 3 inches.....	120.00
2 chains 10 feet long, 2½ inch.....	62.40
4 cast washers 9 inches diameter.....	2.46
Timber for A frame (all other timber was obtained on the ground) 3,200 ft. B. M. at $34.....	108.80
Lower 50 feet round timber, 56 feet long bought on tree.	32.00
Team work	65.00
Carpenter work	231.40
Superintendent	60.00
Common labor	112.00
Nails, etc.	29.40
	$1,531.76

This is less than one cent per cubic yard of the material handled and less than one-half of the cost of a wooden trestle in the same place. This method has also been recently successfully used over a swamp where it was found impossible to maintain a timber trestle.

The logging industry by itself presents an extensive field for the cable and many new details have been worked out for this purpose. One modification is the skidder, where instead of lifting the entire weight of the log, one end is allowed to drag or skid along the ground, though it is so arranged that, when crossing a valley, the whole load could be lifted. Skidding is more useful for pine than for hard woods, as the latter are more scattered, and the skidder to be profitable requires over 8,000 feet of timber to the acre. It can log an area of from 700 to 1,500 feet in any direction from the head spar where the engine is located, or from 30 to 50 acres between moves.

Another system of logging is the pull boat method, which was the first steam logging system that was tried in the cypress swamps of Louisiana, and originated from simply placing a hoisting engine on a scow and dragging the cypress logs out of the swamp, but the condition of these swamps, being covered with the cypress knee, made it almost impossible to get the logs out without the improved methods. One of the small but very important details in snaking logs by cable is the steel cone-shaped cap or pilot placed on the end of a log in such a way that the logs will glance by stumps or other obstruction and can even be pulled around a tree.

An ingenious loading derrick is used by the Lidgerwood company. It rests on an ordinary flat car, and, on reaching the site where the loading is to be done, supports or blocking are placed at the sides of the track and the entire frame is jacked up clear of the track. Then a stationary engine on the frame pulls the car from under, so that the boom of the derrick can load the empty car. In fact, the der-



U. S. BATTLESHIP MASSACHUSETTS TAKING COAL FROM THE COLLIER MARCELLUS IN 800-POUND BAGS BY LIDGERWOOD MARINE CABLEWAY.

rick can pull a whole train load of empty cars under it, one at a time, and give each one its load in passing.

Another use for the cable is for loading and unloading ships in places where there is no harbour within two miles or so of the shore, as in many cases in South America, but a prettier use still and one where no other mechanism can take its place is in the passing of coal between two vessels, especially when both are moving at a rapid speed and the ocean is more or less rough.

The first marine cableway was successfully installed on the U. S. collier "Marcellus" where 20 to 24 tons of coal per hour were transferred, two bags being carried on each trip, and the speed of the ships being from 5 to 6 knots at the time. The second trial was on the British collier "Muriel"

where 35 to 40 tons per hour were transferred over a moderate sea, and through a half gale of wind to H. M. S. Trafalgar, the battle-ship maintaining a speed of from 8 to 11 knots. Another experiment was made with the Russian battle-ship Retvizan, in which special electric hoists were designed by the General Electric Company to meet the requirements of the Russian Navy. These had a speed of 1,200 feet per minute for the full load or 2,000 feet per minute for a half load. The best record was in the fall of 1906, when the Royal Italian cruiser Liguria was coaled. In this case, the cables were guaranteed for 40 tons per hour, but actually passed 60 tons per hour, while the trial board reported the actual capacity as from 70 to 80 tons.

The entire apparatus should be carried on the battle-ship and not on the colliers, and, as Mr. Roosevelt is fond of explaining, there is only one vessel that has less available space than a battle-ship and that is a torpedo boat. So the utmost pains are taken to make the entire equipment as compact as possible, and it now only takes up about 200 cubic feet and weighs less than 7 tons, the entire cost being in the neighborhood of $20,000.

The hoisting gear, etc., is usually designed to be used for other purposes when not handling coal. Sea anchors have been invented to maintain a uniform strain on the cables, some being in tandem, umbrella shaped, and where the front one is 9 feet in diameter and the rear one 3 feet in diameter, it has been estimated that the pull exerted on the cable would be 9 tons when the ships are going at the rate of 7 knots or about 12 tons when the speed is 8 knots.

While these experiments have been eminently successful, they have so far been a labor of love to the manufacturers, although a very vital question to the navies of the world.

Another use is now being worked out, for saving life and cargoes from a wrecked vessel which cannot otherwise be approached, and in order to do away with the necessity of sea anchors, which would not be efficient in this case, Mr. Spencer Miller has recently designed a slip drum friction, using a patent cork insert. Ordinary frictional connections are designed to hold, until a positive clutch is applied, but not to slip; therefore with an ordinary frictional connection, sea anchors or some substitute would be required, for a uniform strain must be kept on the cable; one reason for this is that the coal must never be allowed to touch the water, for fear of spontaneous combustion later on. This frictional clutch is on the principle that if the force of the brake is not sufficient to make the wheel skid but just to allow it to turn, it will come to rest in half the time.

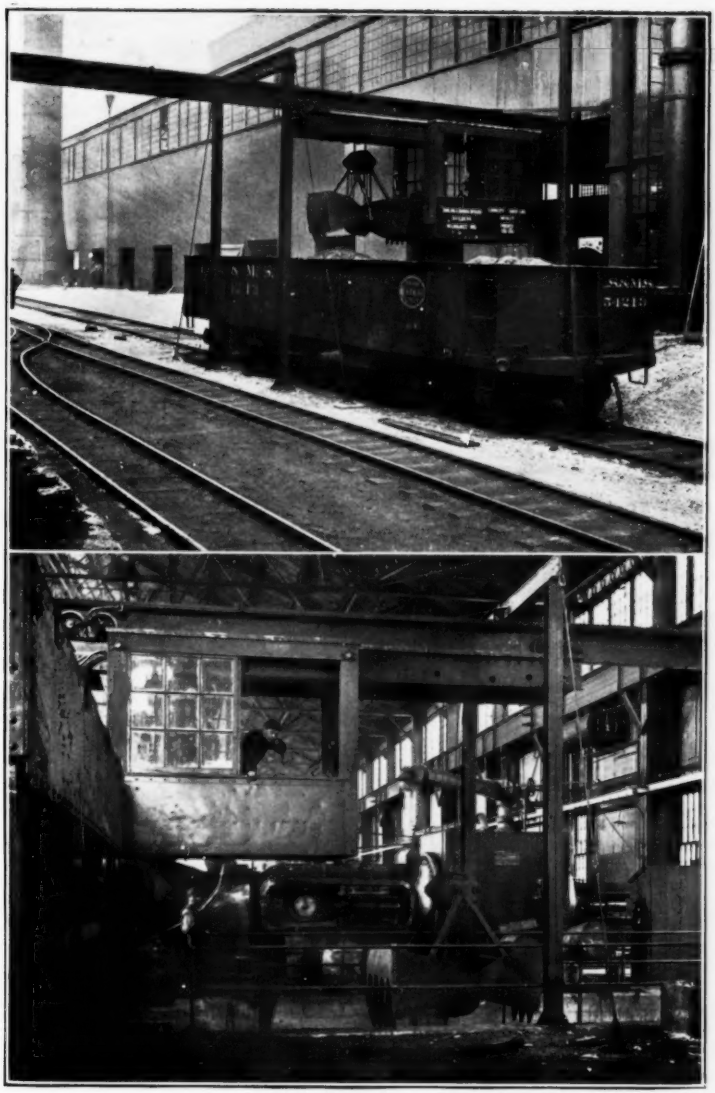
ROBINS CONVEYING BELT REMOVING EARTH AND ROCK.
Employed by Chas. F. McCabe for handling 10,000 cu. yd., Jerome avenue, New York.

Belt conveyors occupy an important place in handling material, and when Ryan & Parker were excavating for one of their East River Bridge contracts, they asserted that their belt worked so satisfactorily that they could lift anything from heavy rocks to a hen's egg, and even handle the latter without letting it roll off or break.

Hoppers are generally arranged to feed the right amount of material automatically onto the belt, and others to receive the material at the other end. The continuous belts can be run on the level or up fairly steep inclines, and are very much used in the grain elevators. Sometimes the belts are run on plain spools and at others with spools having a dip in the center, the sides of the belt often being stiffened up to stand the extra strain. Hundred-pound boulders have been dropped on a 30-inch wide moving belt without stopping it.

It is claimed that the concrete materials, sand, and stone for making 70 cubic yards of concrete have been elevated 26 feet, by a belt conveyor, to the bins feeding the mixers, at the expense of only 7 horse power. A belt with a 500-feet horizontal and 25-feet vertical stretch has carried 900 tons in a 10-hour day using between 8 and 9 horse power.

In Cuba and elsewhere, instead of using a belt to handle the bagasse (sugar cane after all the sugar has been squeezed out) as it is



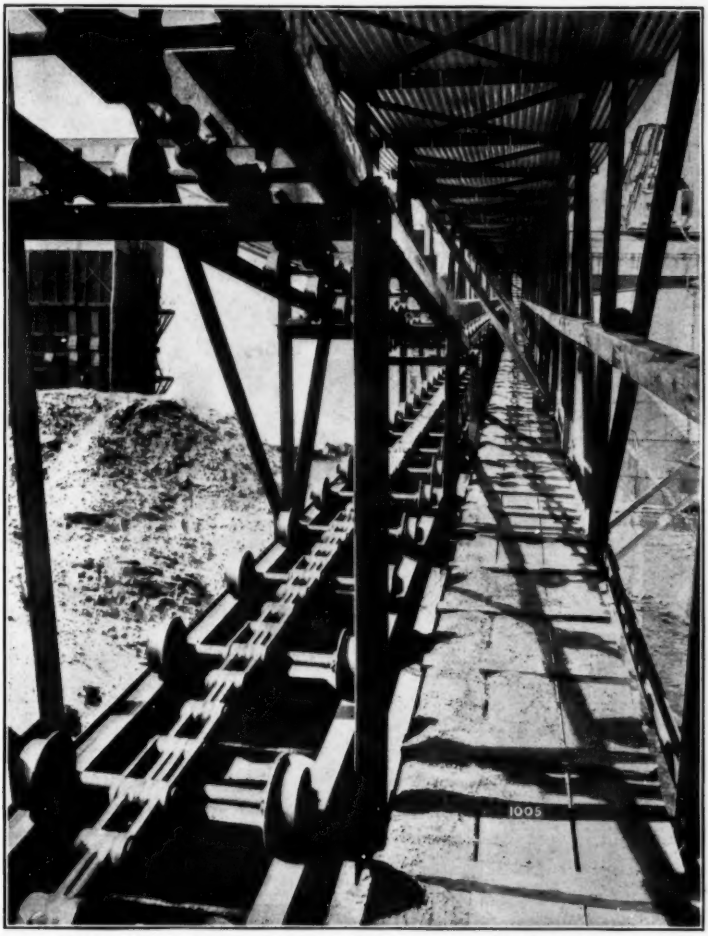
ELECTRIC TRAVELING HOIST, WISCONSIN STEEL CO., SOUTH CHICAGO.

Travels on bar rails fastened to lower flanges of an I-beam runway. Operates specially designed bucket removing scale deposit from the hot rolls. Capacity of hoist 3 tons; hoist speed 70 ft., travel 150 ft. per minute. Length over all 21 ft., lift of bucket 26 ft. Installed by Pawling & Harnischfeger.

fed to the furnace, New York contractors, like August Smith & Co., supply a sort of inclined steel trough over which a continuous carrier travels, scraping the bagasse along and dropping it through various gates and openings to feed the different fires as required.

PORTABLE LOADER AT WORK ON STREET GRADING.
This machine is said to have loaded 300 cu. yd. a day at a cost of 3 to 4 cts. per cu yd.
Whiteside Loader & Machinery Co.

Obviously when the incline is vertical or very steep, a belt by itself would be useless; so we have many different forms of bucket conveyors, the small buckets being arranged in the form of a continuous belt. These are very extensively used for coal-handling plants as well as many other purposes such as handling broken stone, sand and cement for concrete, digging ditches, on dredging machines, etc. One use, however, for which they are not to be recommended, although used, is for handling concrete or any similar mixture which would have the tendency to set and adhere to the buckets or mechanism. The buckets are designed to run around horizontal as well as vertical curves. Many of us use as a mental basis of comparison the fact that we have seen day laborers shovel dirt in the country at a cost of 25 cents per cubic yard, and we know that if the material is handled several times at this rate (as it very often is), the expense amounts up to a very considerable sum. Nature has supplied the cheapest of all methods of handling material—gravity, which should be made use of very much more than it is, in self-dumping wagons, cars, buckets, which should, where possible, be dumped into bins or

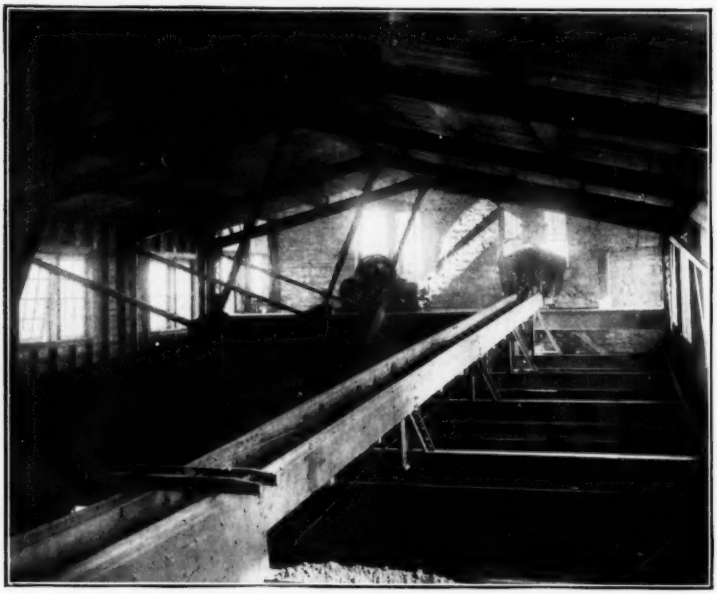


ROLLER CHAIN CONVEYORS FOR CARRYING COAL, CAMDEN COKE CO.

Trough made of two 10-in. channels with ¼-in. bottom plate; links drop-forged; weight of chain and flights taken on 5-in. self-oiling rollers. Length 300 ft.
R. H. Beaumont & Co.

onto platforms, having chutes underneath through which the sand, stone, ore, grain, or what-not can be drawn as required. Perfectly obvious facts, but not utilised to anything like the extent that they should be; for we often see material handled at the cost of from 25 cents to a dollar that a good crane would handle for 3 or 4 cents.

The gravity method evidently appealed strongly to Col. Hains,



COAL STORAGE AND DELIVERY SYSTEM FOR BOILER PLANT.
The coal is drawn from the tower, through a hopper, into an automatic railway car. The tracks run the entire length of the storage bins over the boilers, and the car discharges at any point. From the bins the coal is drawn to automatic stokers.
The C. W. Hunt Co.

for he not only uses gravity for handling concrete materials, but also for mixing them. He dumps all his material, either by derricks, belts, or other contrivances, into a hopper which in turn dumps into another, four or five being arranged one over the other, and the wet concrete comes out of the bottom ready for use. This is a very active competitor of the cubical, Smith, and other mixers. Sometimes one is the cheaper and more thorough mixer and sometimes one of the others is the best for a given locality. Of course, if the point of supply is much higher than the point where the concrete is taken from the mixer, the gravity method would have an extra advantage.

A concrete plant that can turn out 2,000 to 4,000 cubic yards of concrete a day is a very profitable investment where such an amount of material can be taken care of. We used to figure that it cost one dollar per cubic yard to mix concrete by hand, when all the material was delivered, and it would probably cost more now on account of the concrete men's union, while by the use of the best machine, the cost is now a small fraction of a dollar, according to the quantity used as well as the location.

THE FUNDAMENTAL PRINCIPLES OF WORKS ORGANIZATION AND MANAGEMENT.

II. DEVELOPING NEW PRODUCT AND DETERMINING SHOP COST.

By P. J. Darlington.

As explained in the introduction to the first section of Mr. Darlington's discussion, his object is to reduce some of the great problems of works management to their fundamental elements. The multitudinous and sometimes mysterious systems of stock keeping and cost keeping he finds to be resolvable into a very few comparatively simple ideas and methods. His object is to present these underlying principles so that the manager may recognize them, and thereafter adapt and combine them as best suits his special establishment. The preceding part dealt with stock keeping. This concluding portion deals principally with costs.—THE EDITORS.

HAVING decided to add the manufacture of a new line of product, how can we best show, after a time, how profitable the undertaking has been and promises to be if continued or extended? Also how can we learn wherein and why our estimates were inaccurate?

Incidental to the mechanical development and commercial introduction of a new product, we often have constantly diminishing costs and expenditures in improving designs, introducing the product, and satisfying customers. During the first year labor and material costs may have been greatly reduced by standardizing design, manufacture, and stock. Prices of materials may have changed. We may have found our first selling prices too high for business or too low for profits, and adjusted them accordingly. Some large contracts may have been extraordinary. Sales may be still increasing in response to already paid advertising. Many of these things may be normal to the undertaking and to be reckoned with in the future, while others are purely accidental, a matter of which we cannot judge without knowing how they occurred.

A mere knowledge in figures of the total or average profits for the entire year would be of little value as a guide to the present or probable future profits in continuing or extending this line of manufacture. Without intelligent correction for accidents and changed prices such knowledge would be unreliable even in foretelling the result of entirely new extension of manufacture. Two modes of attacking the problem are in use:—

1.—By Separate Accounts.

2.—By Order Registers.

1.—By Separate Accounts we may isolate the equipment, production, and sales in a special set of accounts to show annual profits of this line of product separately. This would involve classifying the orders and the inventory of stock. It would also necessitate collecting and extending into money value the material cost, labor cost, special-equipment cost, and indirect cost of every repetition shop order.

After all this we would have figures representing total and average profits which, as noted above, are of comparatively little practical value.

2.—By Order Registers we file estimates and opinions of annual sales, cost of product, and cost of equipment to show, later, on what assumptions our recommendations led to the undertaking. We decide in how many years to write off the special-equipment expenditure, which, with assumed sales, gives the total assumed production.

We catalogue the new product by names, symbols and numbers and assign pages in order registers.

In the shop order register we assign a page each (one line for each order) for the following:—

a. Drawings, patterns, and tools common to all sizes.

b. Drawings, patterns, and tools this size.

c. Parts this size.

d. Complete machines this size.

The last columns are reserved for net material cost and net labor cost.

In this register we enter in condensed form mention of everything expected to affect shop costs—for example, change in design, special features, new tools and, if the order is on account of a large sale, we may enter the shipping-order number as a cross reference, and the name of the customer as a reminder.

At the end of the year we total the cost of equipment orders and divide by the assumed total production which gives the equipment cost each of product. If the actual sales have been less for the year than assumed there will be "Idle Equipment" charge against profits. The direct labor costs we average from orders selected in consideration of their dates and quantities, and in view of noted circumstances and conditions. The material cost is obtained from the latest revision of the master material list at current prices. The indirect cost is determined as hereafter discussed.

We then have the latest reliable shop cost and idle-equipment

charge to compare with recent sales and selling prices, and are in position to determine present profits and the advisability of continuing or extending this line of manufacture.

We have before us in concentrated form all the attendant facts and circumstances which affected the results, together with the order numbers referring to further details if wanted. We also have the data to show separately the profits on any large sale or contract which might otherwise overshadow the averages. These figures with attendant fact and circumstance may be far more useful than bare unexplained figures in money accounts.

This plan does not require the working up and extending of the material cost and indirect cost of every repetition shop order. It is not dependent upon inventory and is therefore available at any time to help settle a question of proposed business extension or change of selling price. It shows not only present conditions but also the progress during the year in reducing costs and increasing sales and profits.

Order registers are usually necessary for reference and for stock keeping and this mere systematic arrangement of them with very few additional data often gives far more useful information than could be had from costly book keeping and accounting. The value of figures is in the facts that they tell. In the absence of attendant fact and circumstance they may fail of intelligent interpretation and may then be useless or even misleading.

This order-register plan depends upon the registering of orders, especially those for equipment; however, if all orders must be registered somewhere, the registry recorded back onto each order, and the orders audited or inspected therefor, then the plan is no less reliable than accounting processes.

SUMMARY.

Where the extension of manufacture affects a small part of the entire business and is of the same general character as other product, it would appear to be usually unnecessary and unprofitable to account it separately.

To prevent over-expenditure, special equipment such as drawings, patterns, and tools may be authorized by a limited appropriation and made on a separate development account. This is comparatively easy, as it does not involve repetition orders of production. As a practical fact such an expenditure cannot be profitably stopped at a limit and an order-register plan may be just as good to show final expenditure beyond the appropriation.

SHOP COST.

Shop cost is made up of:—

1.—Direct material,

2.—Direct labor,

3.—Special-equipment cost (Drawings, patterns, tools etc).

4.—Indirect cost (A normal share of expenditures that cannot be located to any one product).

There is no clear line between the last two items. They may be considered as one, or on the other hand, indirect cost may be further divided according as expenditures are local to the one class of product or more general to the entire works. This further division adds to theoretical accuracy, but there are very practical limits to the complication permissible, and it is not unusual to carry the subject to foolish and unprofitable extreme. However, there are many cases where the cost of special drawings, patterns, tools and experimental work is the largest part of the cost of a product and failure to show it may lead to serious and continued loss. Many works have failed and have later discovered that their capital had been spent for useless and almost unused patterns and tools for special product to catch the fancy of every customer. Whether and how to divide indirect charge must be decided in view of the business and conditions, always keeping the simplest plan until very definite and quantitative reasons call for greater refinement.

We depend upon our knowledge of shop costs to set new selling prices and to determine in what direction to extend our business; also to learn whether it is more profitable to buy or to make an article, and to compare designs and methods of manufacture. A works may be so established in its product and prices that knowledge of shop costs would not be worth much expenditure to get it. Under opposite conditions, a good knowledge of shop costs may lead to building up a profitable industry while competitors are struggling with discarded and unprofitable contracts.

The expense of getting accurate shop costs evidently depends on the range and variety of the product. If a works makes but one article the problem is solved by simply dividing normal expenditures by normal quantity produced. In short, both the value of the knowledge and the expense of getting it differ greatly, depending upon technical and commercial circumstances.

1.—DIRECT MATERIAL may be determined:—

a. From Material Tickets.

b. From Material List direct.

c. From Material List as authority and record.

a. From Material Tickets:—Under stock systems we considered the costs, difficulties and uncertainties of all material-ticket plans and we must now add the pricing and extending of tickets into money values. In being the basis of actual transfer from stock to shop this system contains one strong feature of reliability, but the clerical processes are often so uncertain as to more than offset it. In standardized, repetition manufacture, its continuous demand on the time of producing men and equipment may seriously reduce efficiency and output.

The plan of issuing material tickets in advance from a material list was shown to be a doubtful expedient.

On repetition orders these material-ticket plans call for weighing and recording the same thing over and over, while greater accuracy may be had at less cost from one careful weighing, independently checked with estimates.

In such material-ticket plans results are not available until long after the order is finished.

b. From Material List Direct:—From the drawings of a new product we make a list of materials to be used, we extend each item at estimated quantity and current price, and total for the material cost of the machine. For each item of material we substitute actual for estimated weight as soon as we can get it. In view of the first assembled machine we make out an independent list of its parts and materials to check with the material list for omission of items. This plan does not take account of material wasted or spoiled, for which a "safety factor" may be used. On the other hand, it may show both rough and finished weights and a scrap credit for the difference.

This plan combines the latest estimates with all actual data and is available at any time, even before the completion of the first shop order. One careful weighing and measuring of each material (checked with the estimate) replaces the many repetitions of the plan just preceding.

Material costs for different sizes of product are easily compared, whereby any serious errors may surely be discovered. When an entire line of product is established—for example, electric motors and generators—the names of items of material and stock parts may be printed down the material-list form, which makes omission impossible and comparison easy by placing the lists together, line to line.

The material list is a necessary part of the authority, instruction, and record of manufacture and stock keeping; therefore, very little

of the expense of keeping it should be charged against cost keeping in this discussion.

c. From Material List as Authority and Record:—The stock room may use a copy of the material list, with quantities left blank, on which to record deliveries to the shop. On completion of the order, this may be checked with the master copy of the material list. This combines some of the elements of reliability of plan a and plan b, but it may often prove too cumbersome and costly, and it is not a good check against omission of items. A more convenient plan is to leave the estimated quantities on the stock-room copy of the material list, with columns in which to enter actual deliveries—in short, to use the material list as combined delivery authority and record, which may discover errors before they are recorded, but loses in reliability by suggesting quantities and weights to the man measuring or weighing the goods.

SUMMARY.

Material-ticket plans would appear to be useful only in work upon repairs or upon product which cannot be reduced to material lists, and where there is no considerable repetition in manufacture.

The use of the material list direct has great advantage in simplicity, and often a small expenditure in comparing and checking it will give more reliable results than several times the expenditure in adding the delivery features.

The plan of using the material list as authority and record must be credited with any help it may give to the stock-keeping plan, but if the stock-room copy of the material list must be consulted before goods are delivered, there may be a delay to production more serious than all else. For merely getting cost of orders, the extra complication would not usually be worth the cost, and as a safeguard against theft its value was seen to be a small and not essential feature of the order-balance stock plan. For conveience the foreman usually has his own copy of the material list.

2.—DIRECT LABOR. In many respects labor resembles material, and much of the foregoing discussion applies to both. There are, however, these important differences:—In labor and wages we are dealing with intangible values which cannot be safeguarded by physical stock keeping or by watchfulness at the gate. Also, labor cost is more within our control and more dependent upon our judgment based on experience. We may be repaid many fold the cost of any plan that makes our experience more available by better

records and easier comparisons of workmen, tools, operations, and designs. Labor may be secured:—

a. From Time Tickets:—

b. From Work Registers.

a. Labor cost from time tickets compares with material costs from material tickets, and is likewise applicable only to special and unstandardized manufacture where work lists would not be possible.

b. From work registers:—When we have designed a new machine to be manufactured, we make up an "operation list" and enter for each operation its best known value, which may be a proven or proposed piece-work price or time cost. Extended for quantity in one machine and totaled, this is the operation cost of the machine. We confirm or correct each operation cost as quickly as its piece-work price is known. This work register combines all cost data to date with the latest estimates, and is always available even before a shop order is completed, and in this respect it is like the material list as used for material costs.

We may now use this operation list as a work register, entering each work ticket (piece-work or time-work) as issued and its cost as completed with extra or accidental cost in red ink.

When the order is finished we have the total cost of each operation opposite its estimate, and the total of all operations should equal the total cost of the shop order as made up independently from work tickets and checked in total with the pay roll. We now have all wages accounted for in detail of operations and compared with former record or estimate of what each operation is worth. This is the only real safeguard against theft or loss of wages, and shows us what we receive in comparison with what it is worth.

The work register of the completed order gives all available information in concentrated form with attendant fact and circumstance and reference (by ticket numbers) to all details. Accidental or extra work is located to the operation on which it occurs, with a reference to the foreman's copy of the work ticket where full explanation may be recorded. We are, therefore, in position to learn how it happened and prevent its recurrence.

The work register brings out those comparisons of men, tools, and methods necessary for low cost, large output, and high quality of product.

3.—Special Equipment Cost is a normal share, apportioned against the product, of the cost of special drawings, patterns, and tools for making it. It is determined by dividing the total shop cost

of such drawings, patterns and tools by an assumed life production of the equipment. If we decide that the investment shall be written off in two years, and if we expect to make and sell 50 machines per year, then the assumed life production is 100 and the special equipment cost of each machine is 1 per cent of the cost of drawings, patterns and tools. If, during the first year, we make only 25 machines, then the difference between 25 per cent and 50 per cent, which is 25 per cent of the investment, is "idle drawings, patterns and tools," loss and should be deducted from the year's profit of the manufacture of that article.

We are interested in this analysis of costs and profits chiefly in connection with the article in question as a guide to selling price and extension of business. The information which we need is given by the order registers as discussed. It is, therefore, usually not necessary to carry special accounts for the purpose. We may carry all such special equipment for the entire works in one account and depreciate it at an equivalent rate annually from plant to expense. The life of the investment is then substantially as before assumed, and it is written off against annual profits through expense account at about the assumed rate, while the great additional expense of subdividing the account is avoided without any sacrifice of practical information.

4.—INDIRECT COST is not essentially different from the foregoing, which it may include. It usually concerns all expenses or expenditures chargeable to manufacture, but not readily located to any one line of product. We must find some approximate way to apportion it fairly to the several articles made before we can intelligently compare costs and profits of widely different product. This problem is of least practical importance when our works are going along under fixed conditions of manufacture and sale.

The shop indirect expense includes interest, depreciation, and taxes, (or rent), light, heat, power, watchmen, janitors, etc. for the building, all of which may be approximately expressed as a value per square foot of floor space. We also have supervision, inspection, stock-keeping and shop-office expenses. For each machine tool, in addition to its floor space occupied, we have interest, depreciation, and power, also the floor space occupied to stack the work before and after machining it. There must also be included oil, waste, perishable small tools, and perhaps freight and express expenditures, and many others. Of these expenditures, some are measureable in time, others in weight or bulk of material and still others are almost

fixed. At best we can only approximate a correct apportionment to different kinds of product, especially where the product varies over a large range in general character of the material and work. For simplicity we may put our distribution on a time basis.

We may work out the value per hour of each machine tool, of floor space per square foot, and of a bench worker's facilities and supplies. We may assume a normal activity of say 200 hours per month. We then extend and total all of these values per month and compare it with the total normal indirect expenditure for one month, and then go back and proportionately change each value per hour to make the total of the monthly equipment values approximately equal to the total monthly indirect expenditure. This gives an indirect rate per hour for a square foot of floor space, for each machine tool and for a bench worker.

If business becomes scarce and the total direct labor falls below normal, then the total of the indirect charges against product will not cover the total monthly indirect expenditure of the works. In this case there will be "idle indirect" balance to be charged directly as loss against the profits for the month.

Such falling off of business does not raise the shop cost of product. There would seem to be no reason for changing indirect costs or percentages to keep pace with such varying activity of the works. Aside from the clerical cost and confusion that would result, it would destroy comparison and cover up valuable information in the monthly statements. It would also raise so-called shop cost in the face of reduced sales, when lower selling prices may be the remedy in filling up the shop and increasing total profits. In any case the management needs correct and comparative data.

The indirect rate of a manufacturing operation is that of the smallest standard machine tool or other equipment suitable. The indirect cost of an operation is the time required (on that tool) at that rate. The indirect cost of an article is the total indirect cost of its operations.

A very large proportion of machine work is done on tools much larger than necessary for each operation. This is usually for good practical reasons, such as to keep otherwise idle equipment and operators profitably employed. For example, the largest planer in a general machine shop may be used to its full size capacity perhaps only a few days per year and is busy most of the time on much smaller work.

Evidently indirect cost must be based on the indirect rate normal to the operation, rather than on the rate of the tool on which the work happens to be done. Indirect cost based on such actual time of doing the work will be in error only due to the difference between the time required with the larger tool and that required with a normal tool. This difference is usually small, and the result is substantially correct not only as to cost of product, but also for determining the activity of any class or size of equipment in reference to questions of department efficiency, capacity for more work of any given class, or need of additional equipment of any type or size.

Evidently this normal indirect rate of the operation may be quoted from the operation list onto the work ticket when it is issued, and there is no demand on the workmen for clerical work in reporting tool used or floor space occupied. This plan is applicable to all kinds of operations, including assembling and testing, the use of portable tools perhaps on costly bed plates, and other operations where the value and rate of the tool are insignificant in comparison with the space occupied by the large work waiting and in progress, perhaps occupying costly floor space under large traveling cranes.

Mistaken theory has led to many absurd systems based on the rate of the tool actually used instead of that normal to the operation, and in many cases even the tool rate is based on actual activity instead of normal activity. The figures so obtained are evidently without meaning and work is driven away from almost idle tools by an enormous and increasing so-called indirect rate. The plan is both impracical and illogical and is usually of no value whatever in deciding questions of cost of product, activity of equipment, or efficiency of departments.

Where conditions of business do not demand the continuous recording and accounting of indirect cost from time tickets, the indirect cost of product may be estimated by dividing the indirect rate of each tool by the average hourly earnings of its operator, which gives an indirect percentage for each tool (and for floor space, etc.). On the operation list of the product each operation cost or piece-work price may be multiplied by this indirect percentage of the tool normal to the operation. The total gives the estimated indirect cost of the article, which may be divided by the total operation cost to give the estimated indirect percentage. If a medium size were selected the result may be used as the approximate indirect percentage of the entire line or class of product. As it is only approximate it may be well to adopt the nearest exact and convenient figure.

SUMMARY.

Where it will meet all practical needs, indirect percentage may be estimated and established for each class of product and need not enter into the factory accounts. It may be very useful in fixing selling prices, in showing profits, in valuing inventory, and in directing extension and growth of business.

Where indirect cost must be continuously recorded and accounted it may be taken from time tickets at the rate of the equipment normal to the operation and based on full time activity.

In attempting to compare indirect percentages of different works it is well to remember that many expenditures are very close to the dividing line between indirect and direct cost. If any such expenditure be classed as indirect in one works and as direct labor in another works, then the fraction called indirect percentage (sometimes called "expense percentage") is doubly affected by taking this expenditure from the dividend and adding it to the divisor.

Rapid advance in mechanical devices for transferring, identification, recording time, sorting tickets, adding and tabulating elapsed time, etc., seems to promise a great improvement and cheapening of the now clerical processes in connection with gate records, pay roll, labor cost, indirect cost, and equipment activity. The correct theory of cost keeping is in every way favorable to the use of such devices, and a rapid advance in the adoption of scientific methods of management will keep pace with the improvement in such means.

STEAM PIPING FOR INDUSTRIAL PLANTS.

By W. E. Housman.

The dearth of practical discussion on the design of pipe lines is an indication of the remarkably small amount of attention given to this most important element in steam-plant design. Imperfect lay-out and construction of piping will nullify the utmost refinements of economy in steam raising and carry grave dangers to the continuity of operation of the plant, but the steam-conveying arrangements of most plants seem to indicate that designers usually concentrate their attention on the steam generators and engines and leave to chance the important link connecting the two. In the following article Mr. Housman deals with the subject in a wholly practical manner, confining his attention principally to medium sized plants designed for moderate steam pressures, but giving a few very interesting data on the distribution of steam underground in mining operations.—THE EDITORS.

WHILE properly designed steam piping plays such an important part in the make up of the modern steam-electric plant, it seems to be neglected and often an after-thought in the more numerous industrial operations. This article will deal with moderate sized plants, and with steam pressures to 175 pounds per square inch.

Steam distribution for power service should be planned at the same time as the design of the buildings and arrangement of machinery. In no other way can the cost be kept to a reasonable amount. Properly designed piping will not only avoid pockets and expansion troubles with the attendant leaking joints, but will simplify and cheapen the cost of erection. With care, every support and sling can be placed before the erection is started, reducing the amount of scaffolding to a minimum, and making certain that the piping will be on proper grade.

To lay out pipe work requires good judgment and acquaintance with standard fittings and steam specialties. Trade catalogues are a far better guide than text books, the little information given in the latter being misleading and the illustrations often harmful.

An accurate scale plan and elevation of all buildings affected should first be made, the roof trusses located and all possible interference plotted. Then the outlines of the boilers and steam users should be drawn in, showing to scale the location of the connections furnished with the apparatus. The general scheme of steam distribution can now be determined, and the boiler-house piping, usually the big end of the work, drawn up. All pipe drawings should be to

such scale as will enable all important dimensions to be given, and should show the position and character of every fitting and support; they should be so complete as to form a thorough specification of the work required.

The steam header, or main, is the natural starting point for a boiler-plant lay-out, and its diameter is determined by the number and size of the boiler connections, and the position of the leads out of the boiler house, bearing in mind that this header is intended only as a distributor, and not as a reservoir.

The connections from header to boilers must be sufficiently flexible to allow the longitudinal movement in the header due to expansion. Never locate the stop valves in a position which, when the boilers are idle, will permit a head of water to accumulate on the seat.

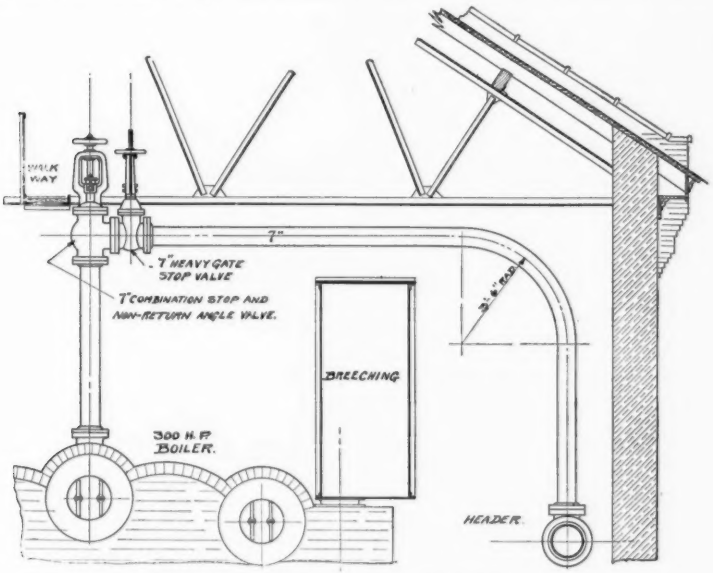


FIG. A. STOP-VALVE CONNECTION BETWEEN BOILER AND HEADER.

The 7-inch connection shown in the drawing represents only one of many in common use. The special angle stop valve illustrated has several trade names. Its purpose is to close automatically should a tube, or any port of the boiler, give way; to keep a boiler closed until its pressure equals that in the steam header; and to protect the man who is cleaning or repairing a boiler. These valves cannot be opened except by pressure from the boiler. When selecting a valve

for this purpose buy one guaranteed against chattering—a fault to which some types are liable.

For small plants and situations where the header can be hung higher than the nozzle on the boilers, the simple 6-inch connection with drain connection, shown opposite, will do very well. This drain is put in at every boiler.

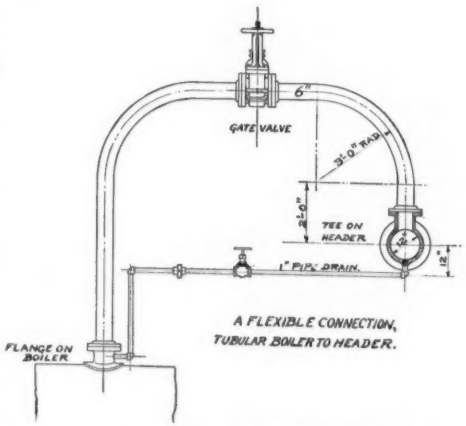


FIG. B. DRAIN CONNECTION BETWEEN BOILER AND HEADER.

To supply the boilers a feed header is carried from the pumps over the boilers, the size proportioned to the horse power of the boilers to be fed. From the header branches are carried to each boiler inlet. By placing this header well to the front of the boilers, the controlling valve on each lead is so situated that an extension valve stem may be dropped down to the reach of the operator on the floor, enabling him to see his gauge glass when handling the valve. A check valve, and an additional stop valve between check and boiler, must be inserted in each lead. The feed piping must be supported in such manner as to be free from the vibration caused by the pulsations of the pumps.

Where non-condensing engines are in use, a good feed-water heater will be installed and sufficient exhaust steam piped into it to raise the temperature of the feed water to 210 degrees. Six pounds of exhaust steam will heat one pound of feed water to this degree, making a total of seven pounds of feed water for the six pounds steam. The heater is set close to the feed pumps and a sufficient height above the floor to be sure that the hot water will gravitate to the pumps. The exhaust steam at the heater must be so piped as to permit the cutting out of the heater for cleaning or repairs.

The drawing on the next page shows one of several ways in which this by-pass can be arranged. The heater and pumps should be as near the middle of the boiler plant as convenient in order to keep pipe sizes down.

Safety valves should be piped singly to the outside of the building

—never into a header, or a leaky valve will be hard to find. When possible this escape pipe should not rise above the opening into the valve, as otherwise the condensed water will form an additional head on the seat. Vertical escape pipes must include provision for removing this water.

The separate boiler blow-offs are usually gathered in a main which will discharge into a tank or pit safely outside of the building, the purpose of the reservoir being to nullify the force of the escaping steam and water; from this point the discharge is piped or ditched to the nearest wasting point. All blow-off fittings should be very heavy, to resist the scouring action of the sediment, and the pipe is preferably cast-iron.

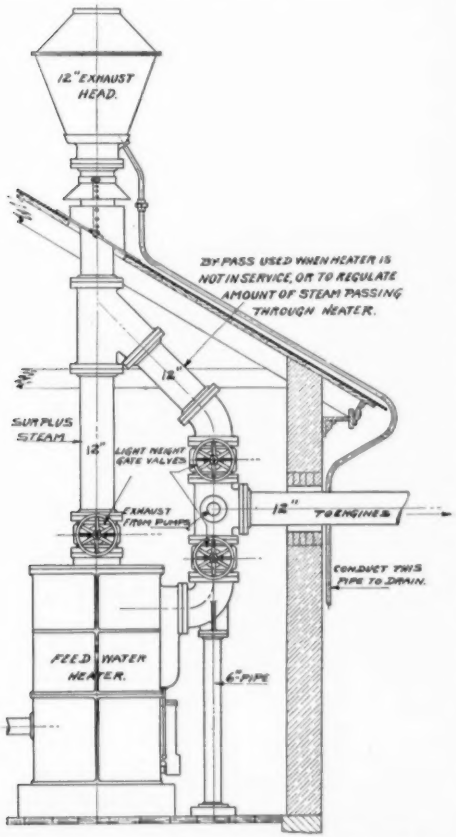

12" EXHAUST HEAD.
BY PASS USED WHEN HEATER IS NOT IN SERVICE, OR TO REGULATE AMOUNT OF STEAM PASSING THROUGH HEATER.
12"
SURPLUS STEAM
12"
LIGHT WEIGHT GATE VALVES
EXHAUST FROM PUMPS
12" TO ENGINES
CONDUCT THIS PIPE TO DRAIN.
FEED WATER HEATER.
6" PIPE

FIG. C. FEED-WATER HEATER CONNECTIONS.

The conditions governing the design of the lines radiating from the boiler plant to the engines will vary so much that only general rules can be given.

Every steam line should start with a valve placed at or very near the connection to the steam boiler, and the grade from this point on should be with the current of steam. With a stiff up grade against the flow, water will collect at the foot of the grade until a slug is formed. Finally it will be picked up and, traveling at high velocity, may wreck the first cast fitting encountered. Therefore, at the foot of every vertical rise and change of grade, a drip pocket or

water leg should be placed, into which the greater part of the water will fall, to be removed by a steam trap. Too much attention cannot be given to this question of drainage. The quantity of water in the steam is variable even in the best covered lines. It will increase as the boilers are forced, or a sudden or excessive demand on the line may lift water out of the boiler.

The more economical way to take care of this water is to put a good separator on every engine connection or branch from a main, and as close to the throttle as possible. For bodies of water in the main, put drip pockets or water-legs at every change of grade, as before suggested. Where reducing fittings are used on the horizontal run, the flanges should either be eccentric or a drip pocket should be inserted next to the fitting and in the larger pipe.

It is best to lead a steam line out of the top or side of a header. However the water leg, under the dropping 10-inch line shown in the drawing below, is expected to care for the greater portion of the water dropping out of the header.

To avoid awkward and dangerous water pockets and to facilitate alteration and inspection, all live-steam lines should be carried overhead. Engine rooms in which the supply pipes drop out of sight immediately on leaving the cylinder look very neat and give the maximum overhead clearance, but the drainage of the unavoidable water pockets created is often difficult, and the location required for separators and traps insures these a minimum of attention.

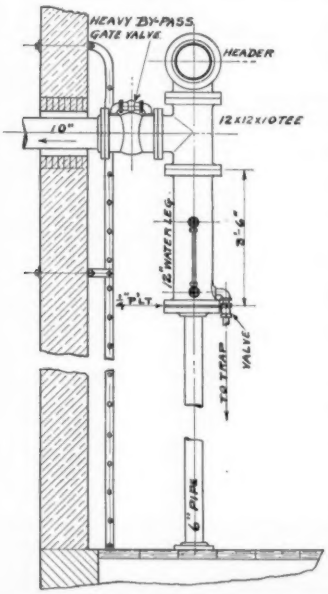


FIG. D. A WATER LEG CONNECTION.

A receiver-separator is very useful at the end of a long line. It not only takes care of large bodies of water, storing them until the trap can expel the water, but it will maintain an even flow of steam regardless of sudden demands made by the steam users. Its use will often permit a smaller line to be used for a predetermined drop in terminal pressure. With high-speed automatic engines, receiver separators are especially valuable; they insure a steady flow of steam in one direction only and serve as a cushion to receive the hammer or vibration due to the

quick action of the steam valve. This vibration is otherwise communicated to the steam line and may prove dangerous to fittings and supports. The connection between receiver and cylinder must be the full size called for on the engine, but the branch from the main to the receiver need be figured only from the steam used in the first quarter of the stroke. They are made in various sizes with any desired arrangement of connections. A receiver of volume equal to seven times the contents of the engine cylinder gives very good results.

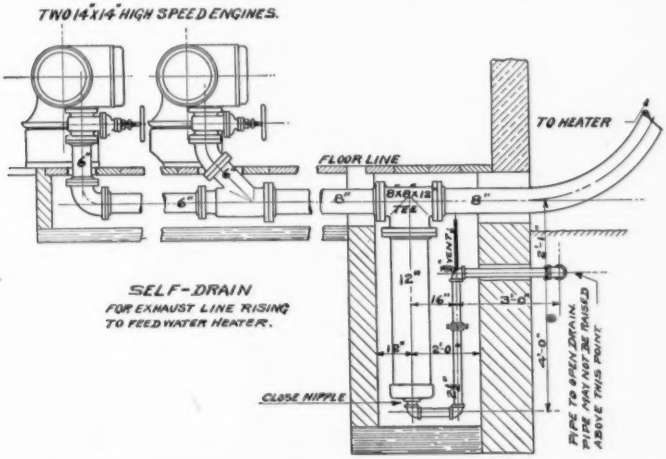


FIG. E. SELF DRAIN FOR EXHAUST LINE RISING TO FEED-WATER HEATER.

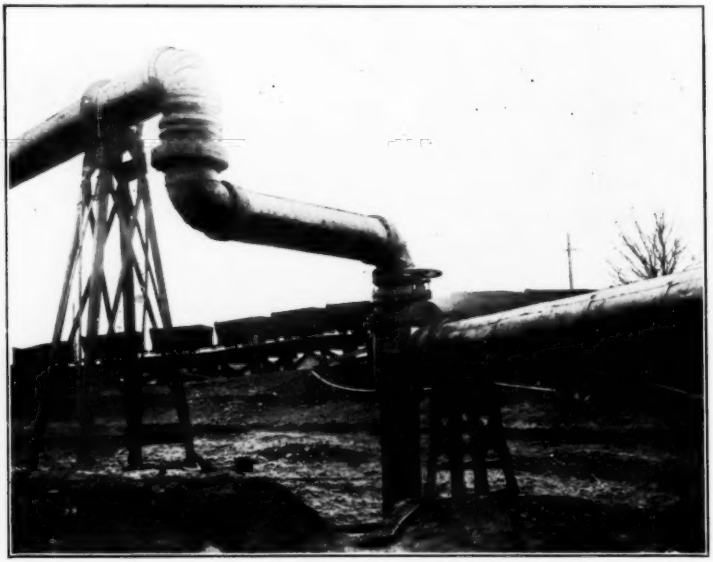
Exhaust lines should preferably drain to the feed-water heater. In any case, water must not be allowed to accumulate, otherwise it may back into an idle cylinder. Traps are a necessary evil on live-steam lines and require constant attention and inspection. On exhaust work their use may be dispensed with by using, instead, a free drain connection having in its water-leg sufficient head to cover the outlet pipe against the back pressure developed. The drawing above illustrates this very simple expedient.

An exhaust head should always be provided for every free exhaust to atmosphere, not only as a muffler but to catch water and oil which would otherwise discolor the roof.

The method of caring for expansion will depend on steam pressure, amount of expansion, size of pipe, and, perhaps, on the position of the line. With pressures under 100 pounds and piping up to 10-inch, a reasonable amount can be taken up by the movement of the threaded nipples in screw fittings. Thus four screw elbows arranged

to form a swing joint will allow expansion in the same manner as the swivel joint hereafter described. The rotary nipples in such joints should be short to throw the minimum bending strain into the ells. For long lines the metallic-packed swivel joint is ideal.

The swivel joints shown in the photograph are located near the middle of a 10-inch line, 900 feet long, the expansion in each half of the line being about 11 inches. With any type of swing expansion joint, the line must be sufficiently anchored to force the expansion to the swing joint.



SWIVEL EXPANSION JOINTS AT MIDDLE OF THE LINE.

Pipe bends are coming more into use for the shorter lines but care must be exercised in their design. Pipe of no less than full weight should be used, with steel flanges. The radius of the bend must be proportioned to the amount of expansion; the longer the radius, the easier on the flanges. A long-radius full-reverse bend is good, but the best expansion bend is one formed of one "U" bend and two 90-degree bends.

The common slip expansion joint is more in use than it deserves. Its chief disadvantage is that the packing gland may be set up so tight that the joint will not slip, but instead, will push out the supports and strain connections. There are sometimes situations in which no other expansion joint can readily be used. The one then

used should be provided with safety tie-rods, so that should the anchorages fail the line cannot blow apart, and the packing had best be metallic.

The anchorages must be figured strong enough not only to overcome the friction in stuffing box and pipe hangers, but also for a stress equal to the steam pressure multiplied by the unbalanced area of the joint. The steam line must be supported close to the slip joint, as a very slight sag in the pipe will cause it to bind. The location of the expansion joint must be determined by the profile of the surface over which the steam line is carried, the amount of expansion, and the type of joint used. Long lines may require several joints, since every sharp change in direction will require provision for expansion.

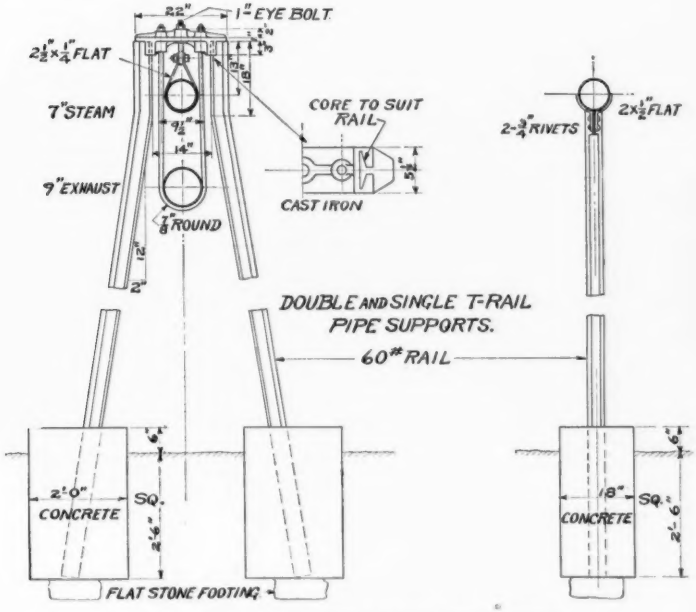


FIG. F. DOUBLE AND SINGLE T-RAIL PIPE SUPPORTS.

Pipe supports will vary with the whim of the designer, and a comprehensive treatment of them is impossible in the limits of this article. For lines where the expansion creep of the pipe is not too great for a sling, T-rail supports are economical, convenient, and neat. At the short-travel ends of the line single-rail supports can alternate the two-rail type. It will be noted on the drawing

illustrating rail supports that the double-rail one can also be used to carry an exhaust line. The cast-iron bracket shown is designed for 60-pound second-hand rail.

The piping must not deflect more than 3/16 inch at the center of the span; the spacing of the supports should be figured accordingly. Additional support must be provided close to all heavy valves and fittings. When the expansion travel in the line is too great for slings, rollers are provided.

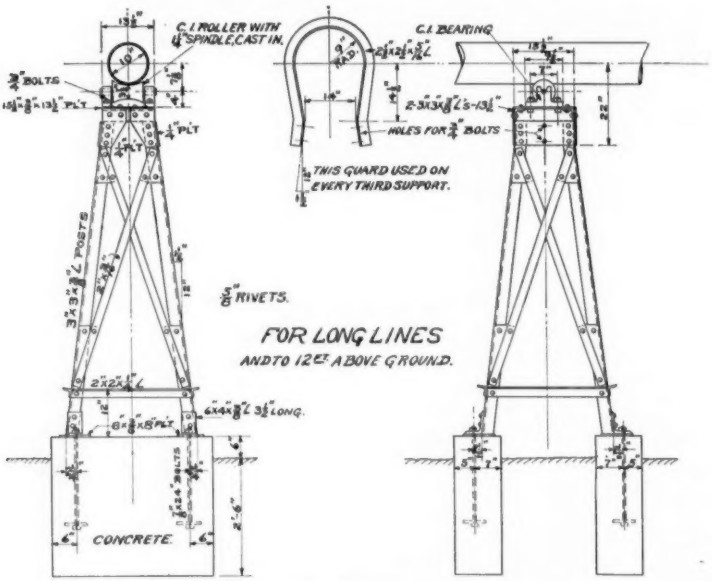


FIG. G. PIPE SUPPORTS FOR LONG AND HIGH LINES.

It may be of interest to touch very briefly on the prevailing method of carrying steam into mines. Formerly steam was taken through a small compartment in the hoisting shaft, thence through the mine to the machinery operated. The line is now carried over the surface to a drill hole put down very near the engine or pump to be supplied. This drill hole is cased, grouted in the hole from bottom to top with neat cement, and the steam line dropped through the casing, the diameter of the casing being only sufficiently large to give clearance to the pipe sleeves or couplings; no flanges are used.

In addition to the water-leg shown on the drawing of bore-hole connections, a separator is placed near the throttle. The swivel joints shown on the surface connection take up the vertical expan-

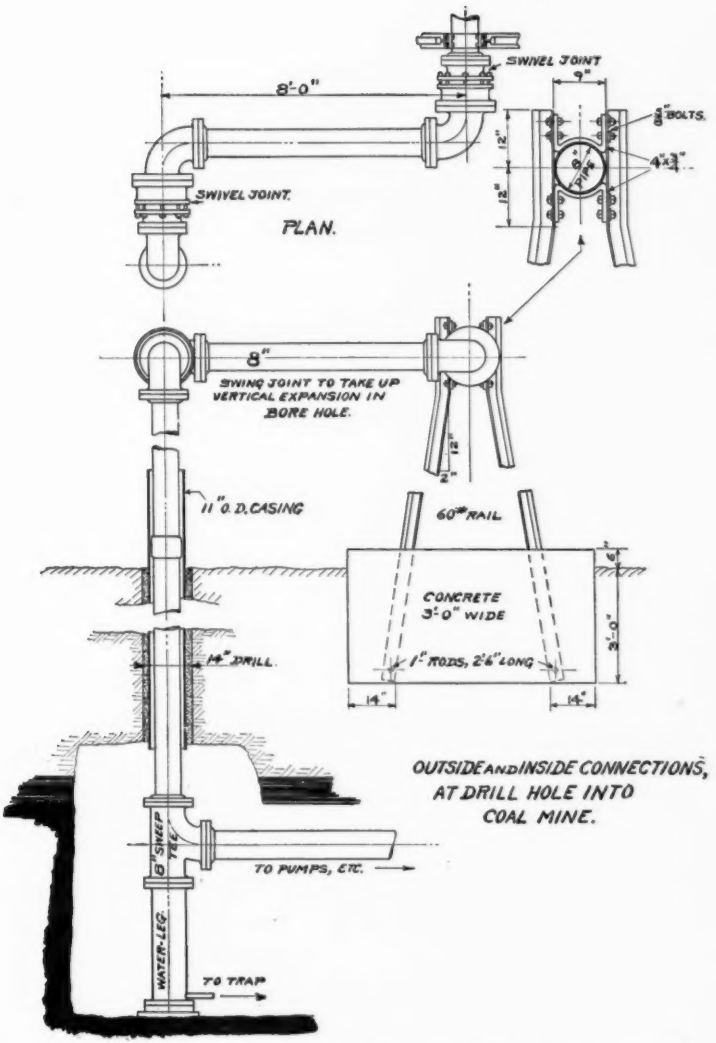


FIG. H. OUTSIDE AND INSIDE CONNECTIONS FOR A PIPE LINE ENTERING A MINE THROUGH A DRILL HOLE.

sion only. When the exhaust steam is not immediately condensed in the mine, it is conducted to a separate drill hole and connected directly to the casing pipe.

As pipe lines in the mine can be very short and direct, the supports present no difficulty; old T-rails, as transverse beams, or as posts under the pipe, are commonly used.

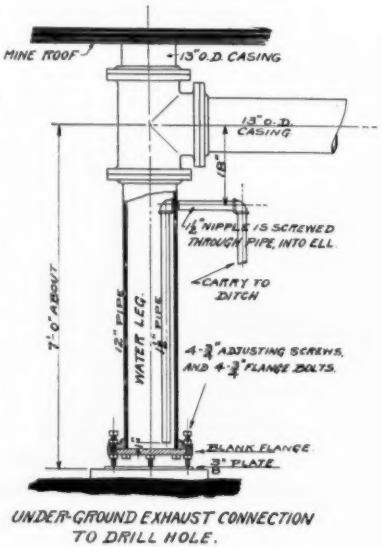
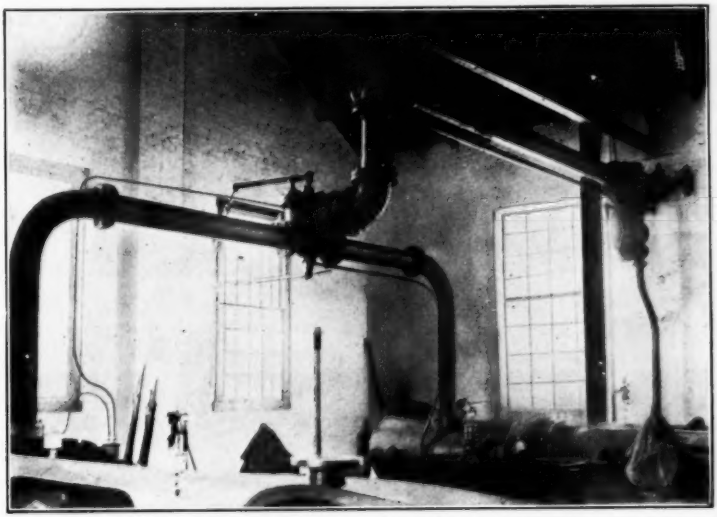


FIG. 1. UNDER-GROUND EXHAUST CONNECTION.

All pipe considered in this article is what is known as "wrought-iron." This has now become a general term which includes all butt or lap-welded pipe of either steel or iron. When material is not distinctly specified, the pipe received will usually be steel, and will be under-weight by from 5 to 10 per cent, the greater variation being on piping from 8 to 12-inch, inclusive; "full-weight" pipe will run very close to the list weight and should be specified on all live-steam work. For bends of radius less than six diameters, extra-strong pipes is often advisable to compensate for the stretch on the outer curve of the bend. Piping larger than 12-inch is listed by external diameter and is called "O. D. pipe." The thickness of metal must be specified in ordering—usually 3/8 inch for live-steam in sizes 14 to 18 inches, inclusive. O. D. pipe lighter than 5/16-inch cannot be threaded.

The best three methods of attaching flanges to wrought pipe, all reliable to 200-pounds pressure, will be mentioned in the order of their cost: When properly made, the screw joint gives perfect results with the minimum cost. The prejudice existing against it in many minds is doubtless due to experience with poor workmanship and to the belief that the threads weaken the joint. It is very rarely wrought piping bursts; but when it does, the break will be found some distance back of the joint and usually not at the seam. To make a good screw joint requires only that the flange be tapped true, the threads on the pipe cut to a long true taper, and the relation between male and female such that the pipe can be screwed home to

the shoulder without heating. Any grit or dirt on the threads will produce added friction and consequent heat, hence the threads must be made clean before applying the graphite or other lubricant used to reduce friction. It must be understood that when a joint becomes hot, it will afterwards leak; the lighter tube will expand more than the flange, while making the joint, and on cooling, will shrink more than the flange. If the thread is of proper length, the end of the pipe will project through the flange. This portion is faced off, at



CONNECTIONS INSIDE THE HOISTING-ENGINE HOUSE.

the same time taking a light cut over the face of the flange. In long steam lines, only sufficient flange couplings are needed to facilitate a repair or alteration, the intermediate connections being the standard forged sleeves or couplings. In emergency, the closing piece of a line, or a section improperly made, can be rectified in the field, as screw pipe can be cut off and re-threaded in the ordinary engine lathe.

The lap joint, formed by machine swaging the end of the pipe over the face of the flange, is absolutely safe and has an advantage in that the flanges, being loose on the pipe, may be turned to match the holes in the fittings. Its cost is about one and one-quarter times that of a screw joint and steel flange. It follows that every joint must be flanged. This joint cannot properly be re-made in the field.

The welded joint is made by machine-welding a forged-steel flange to the pipe. Its cost is about one and three-quarters that of a screw joint and steel flange.

ILLUSTRATING ANCHORAGE AT BOILER-HOUSE END OF THE LINE.

RECEIVER AT THE HOISTING-ENGINE' HOUSE.

Flanges, for live steam, should be of rolled or cast-steel, especially on expansion bends. It is the pipe flange which will fail, almost never the flange on a valve or fitting. They should be rough-faced for thin copper or rubber gaskets. For the pressures here considered, tongued-and-grooved flanges are not necessary and their use makes it difficult to remove a section of pipe or a fitting.

For piping 8-inches diameter and above, flanged fittings are recommended. They offer less resistance to the flow of steam and water and shorten the time and labor of erection. For live-steam work of any size and pressure, the screw fittings necessary should be extra heavy. Bad core setting makes the standard-weight goods unreliable.

The prevailing tendency is toward the gate or straightway valves for all steam fitting. They offer the minimum of obstruction to the flow of steam and water, and the fact that they cannot be opened so rapidly as a globe valve is an argument in their favor. Valves 6 inches and larger should be flanged type. A valve should never be placed in a vertical run of pipe, on account of the water accumulated when the valve is closed. Sizes 8 inch and larger should have a by-pass to warm up the pipe ahead, and to equalize pressures before the main valve is opened. On the larger valves they are indispensable for easy handling.

The flanges on all heavy valves and fittings are now drilled to the standard adopted by a conference of manufacturers in 1901. It is to be regretted, however, that the majority of engine builders and boiler makers have their own standards, which vary widely from each other and from that used on the fittings, requiring companion flanges which are of odd size and drilling.

It seems unnecessary to state that all live-steam and hot-water piping should be covered. Extra-thick or even double covering will be profitable on very long lines. All covering exposed to the weather, or in damp locations, should be protected by good weather-proofing. Moulded coverings are made to fit all sizes of standard screw fittings. Flange couplings are not usually covered, but moulded covering for them can be purchased. Valves, separators, and flanged fittings are protected by plastic magnesia covering put on with a trowel in coats of about one-half inch thick to amount required. On large receivers and O. D. pipe, the covering is applied in blocks of thickness required and curved to conform to the surface to be covered. Exhaust piping is usually not covered unless the heat radiated is a disadvantage.

MAXIMUM PRODUCTION THROUGH ORGANIZATION AND SUPERVISION.

By C. E. Knoeppel.

The article following is first of a group of four developing the possibilities of far-sighted and *fore-sighted* control of a manufacturing business so that it may be operated at a minimum of friction and a maximum of productiveness and profit. The first of the series in concerned chiefly with the adjustment of the internal organization to the utmost working efficiency. The following parts will take up successively systematic processing, machining, assembling and erection; the insuring of economy in the use of material and time; and the methods which secure better deliveries and more satisfied customers.—THE EDITORS.

IN the issues of this magazine for March, April, and May, 1907, there appeared a series of three articles on "Cost Reduction Through Cost Comparison," the object of which was to show how burden, machine, group, part and operation costs could be reduced through an intelligent analysis of results, and how this important work could be so centralized and controlled by one department as to enable the work to be handled under the best of conditions. The series published was complete in so far as the consideration of proper methods for recording and analyzing data and information was concerned—complete in that the application of the principles would enable a manufacturer to locate a leak here, a sore spot there and a wrong condition of affairs somewhere else; but it was *incomplete* in that using only the methods outlined in these articles, the manufacturer would not know that the evils existed until *after* the analysis began. The accomplishment of highest efficiency does not and should not depend altogether upon the analyzing of results attained, and a manufacturer will fall far short of reaching the highest plane if he depends solely upon his information to enable him to remedy a fault in one place—and then does nothing to *anticipate* a fault which may exist in another place, but regarding which he may know nothing until advised by the proper department where the fault was and what caused it.

In any manufacturing enterprise, the securing of maximum production and minimum costs is dependent upon two factors, which being resolved, stand out very distinct as follows:—

1.—Comparison and Analysis	2.—Organization and Supervision

The first factor was considered in the series already published, while the second factor will be carefully discussed in this series; and while each will be complete in itself, their relation to each other will be too pronounced to attempt to cover the ground in the broadest way, by considering one and not the other. "Comparison and Analysis" will, under proper conditions, bring about "Organization and Supervision"; and if considered in this light, the latter, for a time at least, assumes a position of secondary importance, but eventually (when faulty conditions are discovered) the necessity for "Organization and Supervision" is apparent, and this factor then takes its proper place. If on the other hand "Organization and Supervision" receives proper consideration on the start, "Comparison and Analysis" will assume the position of secondary importance, although it must not be inferred that the value of "Comparison and Analysis" decreases as the efficiency of "Organization and Supervision" increases; for in the best managed enterprises it will be found that the former receives most careful attention.

A manufacturer would not think of having the analysis of his irons discontinued simply because he had engaged a foundryman who was skilled in the handling of the cupola, in proper methods of charging, and in the mixing of metals; nor would the engine designer think of doing away with the reading and study of the engine diagram because he knew that on the test block was a man of more than ordinary ability in assembling and adjusting engines. The engineer, through his experience, would take the various parts, assemble his engine, adjust the various motions, etc., turn on the steam, readjust where it was necessary, and take readings; these would probably show to the man trained to analyze them that the engine needed but little readjustment in order to make it come up to specification. Consequently the engine could be built in the quickest possible time and at a minimum cost, while if ordinary workmen had been employed the assembly and adjustment would have taken up the same amount of time at least, and it would then be necessary for the designer, after a diagram had been given him, to spend considerable time analyzing and picking out faults, advising what to do in order to make the engine the machine it was designed to be; this of course would mean that the readjustment would consume considerable time so that the engine would take longer and cost more to build. We can therefore say that—"Organization and Supervision" is to the enterprise what the skilled engineer is to the engine, while "Comparison and Analysis" is to the enterprise what the engine diagram is to the designer.

The doorway to success is open to all who will build their business structure on the two factors heretofore named as a foundation. The one is analytical and critical in its nature—the other creative and constructive. The one considers causes and effects—the other ways and means. The one dissects, diagnoses, and prescribes—the other contrives and devises. The one considers the work *after* it is finished—the other *before* it is commenced and *during* course of construction; and while they may seem to be two different forces at work, they unite on common ground, in that they look into the future—working along different lines for the same end.

Briefly considering this latter factor—"Organization and Supervision," we might define it by saying:—*Its ultimate purpose is to resolve the various forces at work into their component parts—to arrange them so as to enable these forces to follow well defined channels, that the work may be guided along the most logical lines and responsibility placed where it properly belongs; and finally to combine these forces firmly into one harmonious effort, placing at the head a master mind to supervise and direct.*

If consideration is given to the analogy between the business machine (the manufacturing enterprise) and the fighting machine (the company of soldiers) the importance of "Organization and Supervision" is at once apparent. A company of soldiers will accomplish results in the surest and quickest way simply because they are well organized and properly supervised. From the captain to the privates, through the lieutenants, the sergeants, and the corporals, the orders are given and executed in a methodical way without confusion, delay, and misinterpretation; and in the manufacturing enterprise, the orders can be given and executed in a methodical way without confusion, delay and misinterpretation—if, in the growth of the business, in its evolution from the old order of things to the new, proper consideration has been given to the importance of a well trained and efficient organization. I do not maintain that it is possible for the manufacturing enterprise to attain that high degree of efficiency enjoyed by the army company, but I do most emphatically maintain that it would be possible for more manufacturers to be more successful than they are if they would inject some sort of organization and supervision into their business, instead of conducting it in the hap-hazard, disjointed, hit or miss, aim-at-the-ground-hope-to-hit-the-stars way of which so many are guilty. To this class the mere mention of the word "organization" elicits the cry "red tape," although if one of them would once consent to have some of this kind of tape

wound around his business, the results would be so startling as to win him to the side of those who had attained success through a well systematized organization and from whom he could learn how to conduct his own business properly if he would but once get away from his habit of jumping over dollars in an endeavor to save pennies.

If space permitted, we might go into the details regarding the evolution of business in general, from the primitive stage of barter to its present immense propositions. In its early stages business was most simple. If a man had something his neighbor needed and he needed something his neighbor had, a trade was effected; or if a man had several things of like nature, he sold them to others for whatever suited his requirements. As the demand for various articles increased, however, it was found necessary to specialize in a small way, but in a way which enabled a man to devote his entire time and attention to the manufacture of one thing. During this stage of business development, it was an easy matter for the proprietor of the little establishment to give his attention to the various details; in fact, we can safely say that he carried his office "under his hat"—many still do so. As we approach the next stage, we find that conditions, by getting a trifle more complex, necessitated a radical departure, and we find that instead of one man looking after every detail the work has been rearranged so that at least two men divide the responsibility. Tracing still further we will find that as the volume of business expanded, the amount of detail work, necessary to accomplish results, assumed such proportions as to make it utterly impossible for a few men to manage a business properly. We find, commencing at this stage, that segregation resulted and today the manufacturing enterprise, while still a unit, is divided into two distinct branches—the commercial and engineering—these branches being again divided into departments and sub-departments.

While business as it is now conducted is not as simple as it was in the barter days, it must not be inferred that this segregation of authority is synonymous with complexity, for its very purpose has been to simplify and this is what it has accomplished. It is only where this segregation has been the result of lack of thought and proper attention, or other like causes, that we find a complex and unsatisfactory condition of affairs. In fact, there is all about us sufficient evidence that many commercial enterprises are being conducted along lines that, as far as evolutional development is concerned, are several stages behind the times.

Let us suppose a case, which will apply in a greater or less degree

to the majority. In the earlier development, we will say that the founder of the business was able, on account of its small size, to make what sketches he needed, solicit orders, see that they were filled, perhaps take a hand at the making if occasion required, see to the shipments, and attend to the collections and the keeping of his few accounts. He finds that business grows, and eventually places a man in charge of certain branches while he looks after others. The accounts eventually require more attention than he can give them so he engages a book keeper in order that he may be relieved of this work. He finds that the quantity of materials received and shipped amount to enough to warrant a receiving clerk as well as a shipping clerk, and to handle this material from its inception to shipment he conceives the idea of placing a man in charge as stock clerk. He then adds a purchasing agent, in order that he may be relieved of the detail and that the purchases may be made most economically; a man is placed in charge of the orders—foremen are placed in charge of certain men in the shops—the details connected with making plans, drawings, estimates, etc., are taken over by a practical man—his manager is given a person to look after the shops or engineering branch, while the commercial branch with its many details is placed in the hands of another. As the evolution continues, the selling branch is assumed by one man—cost details are looked after by another—a chief inspector is added in order that all work may be shipped according to specifications—the engineer, who before had been a sort of jack of all trades, is placed in charge of certain work while an electrician is engaged to look after this particular work—and so this segregation continues as the development continues.

Perhaps it is not to be wondered at that the founder, in looking backward, is inclined to pat himself on the back when, in a reminiscent mood, he considers what he terms "remarkable development." He considers that he has been wonderfully successful in building up a business which at the beginning was so small as to admit of his supervising every detail, while today he employs a dozen men to do the work he once did. There is no getting away from the fact that it is this same feeling of self-satisfaction that is responsible for a large number of faulty organizations, for if we should tell this manufacturer that his business is far from being as successful as it is possible for it to be he would be very much surprised and perhaps angered—in fact, he would vigorously resent any such accusation; but the fact remains that it is not the success it should be for the very reason that the development has been allowed practically to take care of itself.

New men were added, new officers created, only when absolutely necessary, each new comer being given a general idea of what was expected of him; and not knowing, not thinking, or perhaps not having the time to give more than passing attention to the matter, the proprietor did not consider the fact that his business was a unit, with each worker a part, having a distinct relation with every other worker. Hence as the efficiency of any organization is directly in proportion to the care with which these relations are considered and treated, his organization naturally fails to attain that degree of efficiency obtainable, and for this condition he and he only is responsible. As a result, we find in his establishment a condition of affairs that, shown graphically on paper, looks like Figure 1. We have here an organization composed of managers and heads of departments, but we also have a confused organization in that no one really knows where his authority begins or ends. Consequently, there is no sequence, order, or harmony, and without these it is impossible to obtain maximum results.

If, on the other hand, the proprietor had given due consideration, during the growth of his business, to the importance of a well regulated organization—if he had realized that more could be accomplished through an intelligent supervision than through a supervision where one authority conflicts with another—his organization could then be graphically shown by Figure 2. Compare these two charts, and the difference between an enterprise well organized and properly supervised and an enterprise in which the opposite is the case will be apparent without further argument. Enterprises like the one shown in Figure 1, fail to appreciate the importance of classifying work and duties under their proper authorities, and naturally the result cannot help but be confusion, conflicting orders, arguments, etc.; while the value of an organization like the one shown in Figure 2 lies in the fact that work and duties have been properly classified and placed under authorities most competent to handle them, the effect of which is to reduce to a minimum the friction between the different workers, as well as to enable them to accomplish a maximum amount of work in the shortest time possible.

It is not the purpose of this article to go into details as to work, duties, responsibilities, or authorities. Each establishment has its own peculiar conditions—its own special needs—and the introduction of methods or systems must be made only after careful thought and application. The fact remains however that no matter how complex the existing conditions in any enterprise may be, the matter of

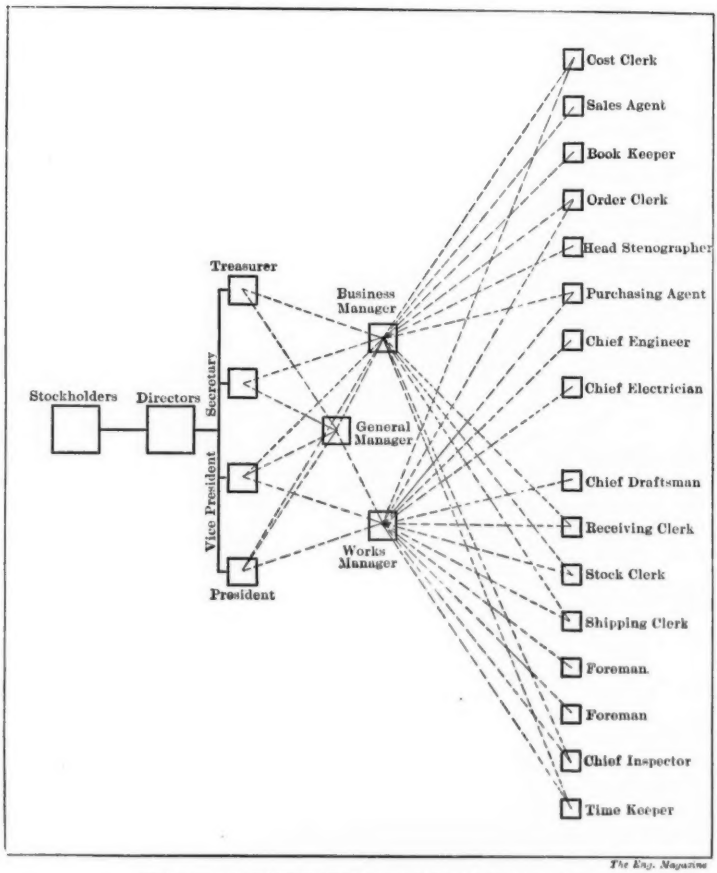


FIG. I. AN ILLUSTRATION OF POOR ORGANIZATION.

properly organizing it is not as difficult as might be imagined, and if the work is started and carried on in the right way it can be accomplished within a short time with gratifying results.

A man is hired and receives wages or a salary, as the case may be, for a distinct purpose—to perform certain duties, and upon the thoroughness with which he performs these duties depends his success; but he depends in turn upon the clearness with which these duties are defined—upon full knowledge as to whom to look to and who are to look to him; yet this part of the contract never receives any consideration at all from many manufacturers. It is therefore

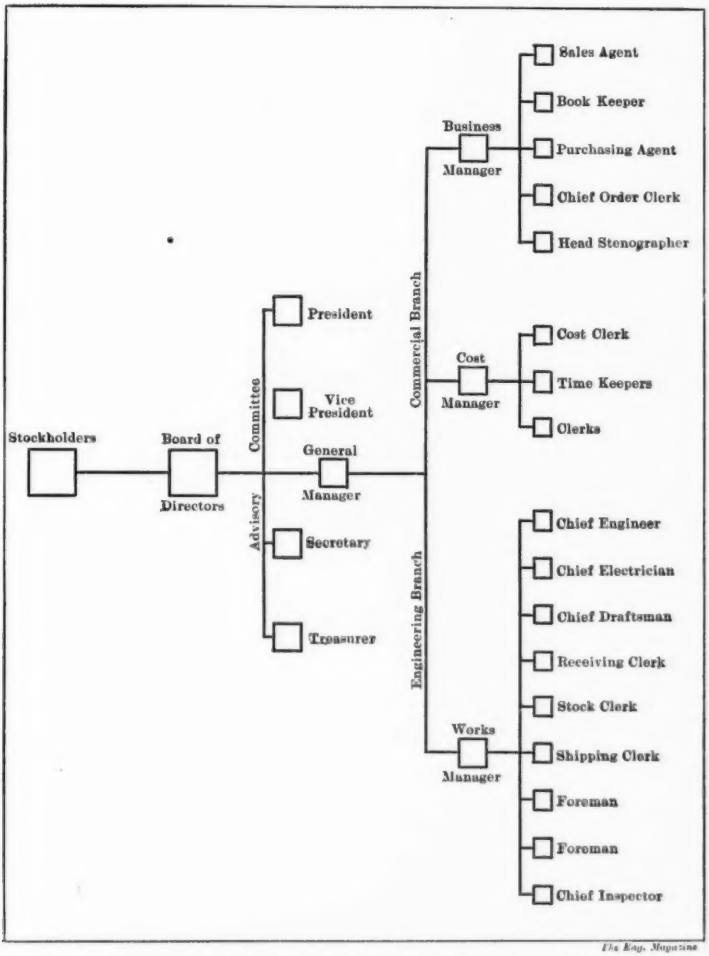


FIG. 2. DIAGRAM SUGGESTING AN ORDERLY AND EFFICIENT ORGANIZATION.

of primary importance, in organizing a business, that a complete list of work and duties be compiled. Provision should then be made for placing these duties in charge of those most competent to handle them, after which it should be decided who shall direct and supervise. It is then an easy matter to classify the details under the proper authorities and we can then draw up an organization chart along the lines shown in Figure 2.

Work and Duties.	Under the Direction of	Under the Supervision of
The figuring of depreciations	Business Manager	General Manager
The purchase of special machinery	General Manager	Advisory Com.
The purchase of materials and supplies	Purchasing Agent	Business Manager
Banking arrangements	General Manager	Advisory Com.
The checking of invoices with materials received	Receiving Clerk	Works Manager
The checking of invoices for payment	Book Keeper	Business Manager
Notes	Book Keeper	Business Manager
Fire protection	Works Manager	General Manager
Appointment of those under commercial authority	Business Manager	General Manager
Appointment of those under manufacturing authority	Works Manager	General Manager
Compilation of sales prices	Sales Agent	Business Manager
Passing on requisitions for materials and supplies:		
Engineering branch	Works Manager	General Manager
Commercial branch	Business Manager	General Manager
The following of purchase orders	Purchasing Agent	Business Manager
The issuing of all shipping orders	Chief Order Clerk	Business Manager
Billing materials shipped	Book Keeper	Business Manager
Experimental work	Works Manager	General Manager
All issuing of materials on written requisition	Stock Clerk	Works Manager
Maintenance and operation of power units	Chief Engineer	Works Manager
The inspection of all work	Chief Inspector	Works Manager
New designs and changes in designs	Chief Draftsman	Works Manager
Statements	Book Keeper	Business Manager
Payment of all bills	Business Manager	General Manager
Collections up to the point of suit	Book Keeper	Business Manager
Collections from the point of suit	Business Manager	General Manager
The ordering of new parts to replace	Chief Order Clerk	Business Manager
Creation of systems	General Manager	Advisory Com.
The issuing of manufacturing orders	Chief Order Clerk	Business Manager
All filing	Hd. Stenographer	Business Manager
The handling of materials for shipment	Shipping Clerk	Works Manager
The maintenance of proper stock margins	Stock Clerk	Works Manager
The determining of proper stock margins	Works Manager	General Manager
Execution of shipments from written orders	Shipping Clerk	Works Manager
Sanitary and plumbing arrangements	Works Manager	General Manager
Transportation	Shipping Clerk	Works Manager
Advertising contracts	Sales Agent	Business Manager
Passing on credits	Book Keeper	Business Manager
Maintenance and operation of electrical equipment	Chief Electrician	Works Manager
Execution of work on time:		
In charge of committee comprising	Works Manager, Chief Order Clerk, Stock Clerk, Shipping Clerk	General Manager
The tracing of all shipments	Chief Order Clerk	Business Manager

LIST OF DUTIES AND OFFICERS TO WHOM THEY ARE ASSIGNED.

The list shown on page 90 was designed to provide a means of enabling a manufacturer to compile duties and then designate the ones to look after and supervise them. The entries shown have been selected at random—the list has been purposely made incomplete on account of lack of space, and is simply suggestive in nature. After a complete list has been made, the work of classifying under proper headings is a simple matter but one of great importance, as the following will show:—

> "BOOK KEEPER, under the supervision of BUSINESS MANAGER, final authority GENERAL MANAGER—shall have full charge of all book keeping, the giving of all notes, the issuing of statements, the billing of all materials shipped, the handling of all invoices received—their checking and passing for payment, cash, the disbursing of money when advised to do so by the Business Manager, pay rolls, time accounts, passing on credits, the enforcing of all collections up to the point where legal assistance is necessary, the hiring, paying, and full charge of assistant book keepers, bill clerks or whomever it may be necessary for him to engage in order to manage his department properly; the arrangement, classification, and handling of his accounts, the right to employ whatever methods he may elect without changing the general scheme of the accounting; and while possessing no authority outside of his own department, he shall have the right to collect such data as are or will be necessary for him properly to compile statements as to the general or detailed conditions of the business."

After this task is completed, the chart of organization can be quickly made, and we then have the proper foundation for an efficient organization. In closing it is necessary to add only that by following the suggestions outlined, a means is provided whereby conflict of authority would be almost entirely eliminated and friction greatly lessened, as we have supplied a lubricant; and as we have succeeded in arranging the various forces in the most logical way, as well as provided for their care in the most careful manner, it is well within the range of reason to expect a maximum production through this factor "Organization and Supervision."

AMERICAN INDUSTRIAL CONDITIONS FROM A WORKMAN'S VIEWPOINT.

A New England Machinist.

This commentary came to us in the form of a letter. It is given to our readers (with the consent of its author) in the belief that its sincerity and earnestness make it valuable as showing the viewpoint of the "other side"—of a member of that most interesting (and rapidly decreasing) class—the American "allround machinist."—THE EDITORS.

AS an American who wishes that the very best in every sense of the word may befall his native land, I feel impelled to comment upon Dr. Louis Bell's article entitled "Wake Up, America," which appeared in THE ENGINEERING MAGAZINE for September, 1906, and has interested me greatly.

My views, I believe, are the same in substance as those of the average working man. I am 54 years of age and have three sons. We are connected on all sides with the old New England stock. A nephew is treasurer of one of the largest plants in New England, a brother-in-law is the head of another important concern. My father was foreman of one of the largest New England foundries. I was born, so to speak, in a foundry, and worked in one from the time I left school at 16 years of age until I was 23. I feel, therefore, that I have some idea of what I am writing about.

For a number of years past, employers in the iron trade in our part of the country have hired apprentices at 65 to 85 cents a day for the first year, "to learn the trade"; instead of taking an interest in these lads and teaching them a trade, they have put them on one class of work and kept them at it, relying upon foreign workmen for their skilled labor. They are thereby taking all ambition out of our native boys, who soon lose any interest in their trade. In the old days there was ambition among apprentices to see who could do the best work. I used to stay many a night after all had gone home to practice on some difficult pattern.

Nowadays the apprentice does not stay his time out except in rare cases. The environment in the foundry and in the machine shop is such that he soon reaches the conviction that he has been and is being unfairly treated. He becomes discouraged, throws up his job, and grows up without a trade. Thus a great many bright men who would become skilled are lost to the industry; foreign workers take their

places, bringing with them their labor-union ideas; when they think the time is ripe, they try and squeeze the manufacturer by strikes, etc., and so the employer reaps what he has sown.

In the old days the manufacturer was satisfied to get a fair percentage on capital invested. He looked upon his help as being next to his own children in his regard. He took an active interest in their moral and spiritual welfare. Well do I remember that when I had lung fever in 1875, William O. Grover of the firm of Grover & Baker, sewing-machine manufacturers of Boston, came to see me every day, bringing flowers or some dish that I could eat—also the surprise I had on returning to work to receive pay for all the time that I was away sick. Yet I was only one out of 1,200 men in his shop.

There was no talk of unions in those days. Nowadays it seems as though the average manufacturer is interested in his help only to get all he can out of them; they are not of as much value to him or to the city or town he lives in as a piece of machinery in his shop; it costs money to buy a machine.

I do not belong to any union or labor society, and I believe labor and capital should go hand in hand. Each has its rights, and should be respected in them. But before there is real rest and peace in the labor world the manufacturer must take the first step. The workman in the average I believe is intelligent. He has an idea how much the railroads of the United States cost, for how much they are bonded, and how much their stock is watered. He has an idea also of the amount of water in corporation and industrial stocks. He believes that he is the real tax payer and he sees the load on his back growing larger each year with no relief in sight.

Personally, I believe that inflated corporations should be compelled to reduce their capital stock out of dividends, setting aside 1 per cent or one-half of 1 per cent annually to redeem and retire the excess capitalization until the capital is reduced to a just valuation.

As mentioned already, I have three sons. They all ranked very high in manual training at school. I prepared them all for the machinists' trade, but they all refused to learn it. The eldest is with one of the great Connecticut shops as draftsman. The second is an engineer on the Boston and Maine Railroad. The third is learning dentistry. His experience, if I may be allowed to give it, is perhaps typical. He graduated from the manual-training department of the high school a year ago. His instructor there wished him to go into a sculptor's studio to study. I had educated him for the machinists' trade and could not afford to pay his way in art; so I told him to look around for a month or two and pick out the shop where he would like

to work. He went to a large number of New England shops, but after his manual-training course and three summers in the drafting department of the concern where his brother is employed, none of them would offer him a better wage than 65 to 85 cents a day. I should make an exception in favor of the large concern just referred to. They offered him a place at $1.40 a day. About this time a dentist who had heard that my son was looking for work wrote me, saying that he wanted a good bright boy to learn his work and offering to pay him $5 a week for the first six months; he actually raised the pay to $6.50 a week for the last three months of this period.

My point is that after all the expense I was at in educating the boy, the manufacturers to whom he went regarded him as a greenhorn, or else to them one boy is just as good as another. The city is which I live has been trying for some time to start an industrial school under municipal and State auspices. Our mechanics as a rule are opposed to it on the ground that they will have to bear the expense of the school and that of sending their boys to it. I have heard some of them say that if the manufacturers will set a fair price which they are willing to pay the graduates of the industrial school, the opposition may be withdrawn.

The manufacturers today all belong to one or more associations for mutual interest. They employ the best legal talent and advice. The workman has no one to look after his interests. I count the walking delegate less than nothing; he only makes bad matters worse. The laborer is sure of nothing. He can only say "I worked today." He knows not of tomorrow. Industrial managers can and do water their stocks; the mechanic can not water his labor. As a workman I claim that I should have some share of profit in our modern expansion, but the cheap labor of the world confronts me on every side so that I must work for the same pay whether times are good or bad. The policy of the day is expansion, contraction, and explosion. How many times can this take place before there will be a revolution? Are we not, with all our boast of greatness, approaching the state of affairs that existed in Rome at the beginning of her decline?

I have told my boys that if labor and capital ever get into trouble they should stay in their houses and mind their own affairs, but if the United States is ever in difficulty they shall take up arms for their country. My forefathers fought against King Philip. There were seventy-nine enlistments of my name from Massachusetts alone in the American Revolution. In every war the blood of my family has been shed. There are no more loyal people than mine—but between labor and capital we will be neutral.

EDITORIAL COMMENT

The Quebec Bridge.

A SUMMARY of the report of the Royal Commission of inquiry into the Quebec bridge disaster is given elsewhere in these pages. In this definition of the objects which the commission set for themselves and in their findings—and far more clearly yet in the full report—will be found an inspiring example of the complete fulfilment of a great responsibility. In realization of the scope of the question, firmness of grasp of all its elements, and convincing justice of its pronouncements, the document has every quality of the strongest judicial decisions in their best form.

Fundamentally, the cause of the disaster was precisely that we defined editorially in our November issue—"the great vision by which vast engineering work has heretofore been carried safely into the region where 'accepted formula' must be carried forward and enlarged, was lacking." The commission metes out individual blame impartially. It lies heavy enough on some shoulders; but it appears, after all, that the failure or the insufficiency lay in the capacity of certain engineers—not, as some of our contemporaries hastily declared, in the capacity of engineering—to solve triumphantly the problems that were here involved.

Efficiency and Economy.

WHATEVER difference of opinion there may be as to the extent to which the recent business disturbance was the result of extravagance, there is very general accord in the conviction that one of its best fruits will be a widespread betterment of economy. If so, the gain may be cheap even at the price. And by "economy" we are as far as possible from meaning mere retrenchment — contraction — clinging to the dollar that circulation brings within our grasp, and faint-hearted retreat from the normal, sensible promotion of sound business. That sort of "saving" is the worst and most irreparable of waste, for it sacrifices forever the two assets that can never be replaced—time and opportunity. It is the child of panic and it begets its like.

Economy is rather the fuller use of the time and money disbursements so that the largest useful product may be returned. It leads not to contraction, but to expansion, for its immediate result is the cheapening of product, the widening of markets, the stimulus to constantly increasing consumption. It is this greater care to make the returns commensurate with the outlay that is being impressed upon both labor and capital by the tension of existing conditions. Workmen realize that when the payroll becomes an object of anxious study, the most efficient employee is the surest to keep his job. Managers find that when orders must be sought with diligence, instead of turned away from already overflowing doors, it is imperative to improve their organization and methods so as to compete with the keenest and most skilful rivals. "Economy and Efficiency" will be the watchword for months to come. With all our progress in manufacturing, the beginning is scarcely yet made in attainment along these lines. THE ENGINEERING MAGAZINE during the summer and autumn will present some of the most important and fruitful studies yet published in this field, embodying the system and practice of the ablest specialists in shop management and reorganization. Definite announcement will follow.

State and Federal Canal Work.

BARGE Canal Bulletin No. 1, lately issued by the department of the State engineer and surveyor under the authority of Frederick Skene, the pres-

ent occupant of the office, is a very interesting and well prepared summary of the progress of the work to February 1, 1908, both in total and by the separate contracts in detail. The introductory comparison between the home undertaking and the Isthmian Canal, in point of excavation so far accomplished, may help to correct the false perspective in which the two enterprises appear to many persons who have not examined the figures. Work at Panama under American occupation began in May, 1904, and that on the barge canal in May, 1905. The latter is hence just one year behind in headway. For the first three complete years the relative progress in excavation shows very favorably for the State enterprise, as may be seen in the figures below given in cubic yards:

	Panama	Barge
First year's work....	243,472	716,676
Second " "	1,799,227	1,460,705
Third " "	4,948,497	4,500,459

The point is made that the climatic difficulties at Panama are offset by the winter interruption in New York State, the work here being greatly impeded or entirely suspended during four or five months; also, that the work of excavation represents much more nearly the total accomplishment at Panama than at home; of the Barge canal it makes but 40 per cent. of the undertaking, the remainder being taken up in the many structures.

In energetic execution and successful accomplishment the result is a tribute to the direction of the State engineering force. There is a striking contrast, however, between the quiet with which this work has gone on near by, under ordinary contract allotment, and the public turmoil over the Federal organization. There is also a strong suggestion that in proportion to the expenditure involved, the Barge canal has been considered very inadequately as to its economic or commercial desirability—that is, if the preliminary studies at Panama are any criterion at all of the care with which a question of such magnitude should be examined.

Acetylene and Forestry.

THE gain made by acetylene lighting in the confidence of insurers is shown by the modification of the National Board of Underwriters' rule touching the installation of generators. Formerly installation within an insured building was prohibited, although the rule was not always nor everywhere enforced. By an amendment adopted at a recent executive committee meeting, this provision is modified so as to read that "generators, especially in closely built up districts, should preferably be placed outside of insured buildings in generator houses constructed and located in compliance with" the Board's specifications elsewhere expressed. This of course changes the outside installation from a requirement to a recommendation.

It is believed that the ruling will be of benefit particularly to the better class of manufacturers and apparatus, and therefore to the more substantial advance of the industry. If only the manufacture of the illuminant could be made independent of the wholesale destruction of timber with which it is now evilly associated, its progress might be welcomed with unalloyed cordiality. It should appeal to the commercial organizers of the industry, who have shown such fair-mindedness and far-sightedness in their acceptance of the suggestions of the insurance engineers, to lend their best aid to the wise protection of the forest growth upon which they are, at present at least, vitally dependent. It would be a violent ill-balance of judgment to lay broad foundations for a business to grow through decades, and yet to take no thought of the preservation of its necessary raw material, which (if our best foresters are to be believed) is within a comparatively few years of exhaustion.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE HYGIENE OF WORK IN COMPRESSED AIR.

THE PHYSIOLOGICAL EFFECTS OF HIGH AIR PRESSURE ON MAN AND PRACTICAL MEANS OF PREVENTING CAISSON DISEASE.

Dr. J. S. Haldane—Royal Society of Arts.

THE first of the Royal Society of Arts' series of lectures on industrial hygiene, delivered by Dr. J. S. Haldane on November 29, 1907, dealt with the hygiene of work in compressed air. The dangers attending work under high air pressures are well known, but the physiological causes which lead to the dreaded caisson disease are not generally understood. The following brief abstract of Dr. Haldane's very thorough discussion of the subject should be of interest.

After outlining briefly the applications and methods of use of compressed air in diving, caisson and tunnel work, Dr. Haldane proceeded to discuss the difficulties and dangers of work under high pressures.

"One of the first things usually observed by a man going into compressed air, or a diver descending, is a sense of pressure and discomfort in the ears. This may rapidly increase to acute pain. It is due to the fact that the middle ear is an air-cavity communicating only by a very narrow passage (the Eustachian tube) with the back of the nose. If the Eustachian tube does not admit air freely the air-pressure in the middle ear becomes less than outside. As a consequence the membrane of the drum of the ear is pressed inwards, and the blood vessels of the wall of the middle ear are distended, so that either rupture of the membrane or bleeding is apt to occur, with resulting temporary impairment of hearing or inflammation, and occasional permanent effects.

"Different persons vary greatly as regards the readiness with which their Eustachian tubes allow air to pass and a cold in the head will often cause an almost complete blockage. By a peculiar swallowing movement at the back of the mouth it is, however, usually possible to open the Eustachian tube, and men accustomed to compressed air can do this without difficulty, and thus avoid all discomfort. A diver descending will naturally stop if he feels his ears uncomfortable. In an air-lock, on the other hand, the inlet tap is not usually under the direct control of the man whose ears are hurting him; and, as a consequence, there may be great risk of ear trouble. Besides the middle ear, there are other air-filled cavities, communicating by narrow openings with the nose cavity; and these also may give trouble if the openings are blocked. During decompression there is much less chance of trouble from this cause, unless the decompression is carried on at a very rapid rate."

To avoid risk of injury to the ears the rise or fall of pressure in the air lock must be regulated according to individual susceptibility. Skilled divers and men accustomed to caisson work can bear a pressure rise of an atmosphere per minute or even less time, but new hands require a much slower rate. In some cases no reasonable rate is sufficiently slow and a person suffering under very slow compression must be excluded from the work. In any case it is desirable that the air inlet should

be so regulated as to prevent a very sudden rise of pressure. The maximum rate should be about one pound in four seconds and the tap should be capable of instant regulation if any one suffers discomfort.

"A second physiological trouble in connection with work in compressed air is well known to practical divers. It is commonly found that after a depth of 12 to 15 fathoms has been reached, the breathing becomes much oppressed, so that the diver's capacity for work is greatly diminished. With further increase in depth the distress becomes greater and greater. It has usually been attributed to the pressure on the body hindering the breathing."

In 1905 the troubles arising from this cause were investigated by a committee of the Admiralty. It was found that the mere pressure of water or air on the body is not responsible for respiratory distress, but that the CO_2 breathed by the diver is the real cause. Under normal conditions the breathing is always regulated so as to keep the partial pressure of the CO_2 in the lung alveoli or air cells almost exactly constant. Under constant barometric pressure, the air in the lungs of each individual contains an astonishingly constant percentage of CO_2; this percentage varies inversely with the barometric pressure and the pressure exercised by the CO_2 itself is constant. "If CO_2 is present in the air inspired the effect is to make the breathing deeper, and finally also more frequent. Unless, however, the pressure of CO_2 in the inspired air begins to approach the normal alveolar pressure, there is very little change in the alveolar CO_2 pressure, compensation being produced very easily."

In the case of a diver, however, supplied with a constant volume of air, the greater the depth to which he descends and the greater the pressure under which he works, the more nearly the alveolar CO_2 percentage approaches that of the inspired air, with the result of increasing respiratory distress. In order that the diver may work in comfort and safety, therefore, "his minimum air supply must be increased in proportion to the increase in the absolute air pressure; in other words, the volume of air supplied to him, measured at the pressure he is under, must always remain the same.

"In the caissons and tunnels it is also necessary to ensure sufficient ventilation to guard against the ill effects from CO_2. To make the effects of CO_2 practically inappreciable it would be necessary to keep the pressure of CO_2 from rising above 1 per cent. of an atmosphere. Where there is no other source of CO_2 besides the persons present, a minimum ventilation of 300 cubic feet per man and per hour, measured at the existing pressure would suffice for this end if the air were properly distributed. If this pressure were 30 pounds this would correspond to 900 cubic feet, measured at atmospheric pressure. The possibility has to be borne in mind, however, of other sources of CO_2 and other air impurities. If candles are used, or if there is blasting, or decomposition processes are occurring in the mud, there may be present not only more CO_2, but also carbon monoxide, sulphuretted hydrogen and other poisonous gases. As compressed air is expensive, it is important to avoid all unnecessary sources of air impurity so as to render any excessive ventilation unnecessary. The air ought also to be properly cooled before it is delivered as otherwise the working space becomes uncomfortably hot and the work is hindered. . . .

"I now come to what is the most important special risk in connection with work in compressed air. Since the early days of diving it has been well known that after reaching surface divers in deep water are liable to sudden attacks of illness. Sometimes death occurs within a very short time, but paralysis, particularly of the legs and bladder, is much more common, so that the illness received the popular name of 'divers' palsy.' Often the paralysis passes off after a time more or less completely, but it may be permanent or may lead to a lingering fatal illness. Among workers in caissons and tunnels at high air-pressures similar cases of death or paralysis, or attacks of syncope, sometimes occur shortly after the men leave the air-lock in coming out. By far the most common symptoms is, however, an attack of pain in one or other of the limbs, or occasionally elsewhere in the body. These pains are known to the men as 'bends' or 'screws,' probably from the fact that the affected limb is usually bent to ease the pain, and that the pain itself is

sometimes so intense as to feel like something being screwed into the affected part. The pains fortunately pass off soon. They usually occur within about an hour of leaving the air-lock. The whole group of symptoms has come to be known under the somewhat unfortunate name of 'caisson disease,' which suggests some sort of chronic malady."

The explanation of these symptoms was made 30 years ago by Paul Bert, a French physiologist, but it is only recently that the value of his work has been fully recognized. The explanation depends upon the fact that when a gas is brought into contact with a liquid, the latter takes up the gas in simple solution until a state of saturation, depending on the "co-efficient of solubility" of gas in the liquid, the temperature of the liquid and the pressure of the gas, is reached. The blood passing through the lungs of the worker in compressed air takes up an increased proportion of nitrogen and oxygen in simple solution. The increased proportion of oxygen adds but slightly to the total oxygen in the blood and it practically all disappears when the blood reaches the tissues. Unlike the oxygen, however, the inert nitrogen does not enter into chemical combination with the tissues and gradually the whole body becomes saturated with nitrogen at the pressure (79 per cent. of the total atmospheric pressure) which this gas exerts in the compressed air. If the excess of air pressure is now rapidly removed, the blood and tissues will for a time be in a condition of super-saturation for the diminished pressure, and the nitrogen will tend to liberate itself within the body in the form of bubbles. Bert concluded that the clogging of the blood vessels in this manner caused the paralysis and other symptoms of caisson disease and his conclusions have been fully confirmed by recent tests on living animals, made under Dr. Haldane's direction, and by post-mortem examinations of men who have died of compressed air illness.

In order to counteract these effects decompression must be slow, but the safe rate has never been accurately determined. The rates used in ordinary practice have proved more or less unsafe when exposure has been long continued in an atmosphere in which the excess of pressure has exceeded one and one-half atmospheres. Recently very extensive investigations have been carried out by the Admiralty on goats and the results of these experiments are summarized by Dr. Haldane. They have had the important result of disproving the theory that decompression should take place at a uniform rate. Practical experience has shown that even with very rapid decompression, no symptoms of caisson disease occur with an absolute pressure of two atmospheres, and symptoms are very rare and slight until the pressure rises above 2.3 atmospheres. It was argued from this fact that, since the volume of gas tending to be liberated would be the same in each case, it would be equally safe to decompress rapidly from six to three or from four to two atmospheres, as from two to one. Experiments with goats have shown that this is the case, and that the danger of rapid decompression depends, not on the absolute difference between the final and initial pressure, but on the proportion between the two.

Dr. Haldane is confirmed in the belief that stage decompression should be used instead of regular decompression. Calculations on the principle mentioned above show that, however slow uniform decompression may be, the difference in partial pressure between the nitrogen dissolved in the tissues and the external air pressure will go on increasing and at the end of the decompression the danger will be at a maximum while the first half of the decompression time is wasted. In stage decompression the worker is brought rapidly to half the absolute pressure, stopped there for a time, and by repeating this process brought finally to atmospheric pressure, the maximum nitrogen pressure in any part of his body never becoming more than twice the nitrogen pressure of the air at the lower stage. The method has been given a trial in diving work and the results have been excellent. Dr. Haldane has no doubt that its proper application in caisson and tunnel work would remove a great part of the danger of compressed air illness and the necessity for the elaborate medical and emergency establishments now such a necessary part of all large works using compressed air.

THE QUEBEC BRIDGE DISASTER.

A SUMMARY OF THE FINDINGS OF THE COMMISSION OF INQUIRY APPOINTED BY THE CANADIAN GOVERNMENT.

Report of the Commission.

AFTER five months of continuous labor on the part of the commissioners, the unanimous report of the Commission of Inquiry on the Quebec Bridge Disaster was presented to the Canadian Parliament on March 9. We present below an outline of the investigations made and a summary of the conclusions reached by the commission, as contained in the introduction to the report:

"In carrying out our instructions we have made the following investigations:

"(a) A study of the history of the Quebec Bridge and Railway Company, the evidence at our disposal being copies of the various public acts concerning it, the minutes of the directors' meetings, the reports of its officials, its annual reports, its correspondence and copies of the agreements and contracts that it has made.

"(b) A perusal of the entire correspondence on file in the offices of the Quebec Bridge Company, the Phoenix Bridge Company and of Mr. Theodore Cooper.

"(c) A study of the working organizations of the Quebec Bridge and Railway Company, the Phoenix Bridge Company and the Phoenix Iron Company. This involved the hearing of a number of witnesses under oath and the examination of the various documents produced by these witnesses on directions of the Commission and filed as exhibits.

"(d) A personal inspection of the furnaces and rolling-mills by which most of the metal that was used in the bridge was produced. The testing equipment at each of the works was examined and the file of the record of tests made by the inspectors during production was gone over.

"(e)) A study of the methods used in the fabrication, transportation and erection of the bridge. This consisted of inspection of the shops of the Phoenix Iron Company, in which all the metal was fabricated, and an examination of the plans, records, correspondence and photographs on file in the office of the Phoenix Bridge Company. The fabricated material for the north half of the bridge was also inspected and check measurements were taken to determine certain questions of workmanship.

"(f) A study of the errors in workmanship detected by the several inspectors during the progress of the work, the evidence available being the record books kept by the shop inspectors for the Phoenix Bridge Company and for the Quebec Bridge and Railway Company, the 'field corrections' sent by the Phoenix Bridge Company's resident engineer to the erection department of that company, and the weekly reports made by the inspector of erection for the Quebec Bridge Company to the consulting engineer.

"(g) An inquiry into the history of the erection of the bridge. This inquiry was made by obtaining direct evidence from witnesses under oath and by tracing out through records and correspondence the details of all the major difficulties that had occurred in the course of construction.

"(h) An endeavor to obtain from eyewitnesses of the disaster all the details concerning it. Some twenty-five witnesses were examined for this purpose.

"(i) An examination of the meteorological records of the day of the accident and for some time previous. The records of the observatory at Quebec and those kept by the Phoenix Bridge Company's staff were available for this purpose.

"(j) A personal examination of the fallen structure made at different times and occupying several days, together with such surveys, check measurements and photographs as were considered necessary.

"(k) A study of the methods adopted in the design of the bridge. This study required an inspection of the drafting office of the Phoenix Bridge Company, and an examination of the mass of preliminary and final designs on file there. The sworn statements of all the senior engineers formed an important part of the inquiry.

"(l) A checking of the stress sheets prepared in the offices of the Phoenix Bridge Company by comparison with results obtained by Mr. C. C. Schneider, consulting engineer, who was employed subsequent to

the disaster, by the Department of Railways and Canals, to report to it on the design of the bridge.

"(m) A comparison of the organization and specifications used for the Quebec Bridge with those used for existing great cantilever bridges on this continent.

"(n) A replotting of the records of tests made on full-sized compression members and a comparison of the design for the principal compression chords of the Quebec Bridge, with similar designs for other great cantilevers. In this connection special tests were made both by the Phoenix Bridge Co. and by the Commission, the details of which are given.

"(o) A study of the theory of compression members, standard books, transactions of technical societies and professional journals being consulted. The purpose of this part of the inquiry was to determine how thoroughly the designers of the Bridge availed themselves of the professional knowledge at their disposal."

In the summing up of the investigation, the report says:

"Your Commissioners find:

"(a) The collapse of the Quebec Bridge resulted from the failure of the lower chords in the achor arm near the main pier. The failure of these chords was due to their defective design.

"(b) The stresses that caused the failure were not due to abnormal weather conditions or accident, but were such as might be expected in the regular course of erection.

"(c) The design of the chords that failed was made by Mr. P. L. Szlapka, the Designing Engineer of the Phoenix Bridge Company.

"(d) The design was examined and officially approved by Mr. Theodore Cooper, Consulting Engineer of the Quebec Bridge and Railway Company.

"(e) The failure cannot be attributed directly to any cause other than errors in judgment on the part of these two engineers.

"(f) These errors of judgment cannot be attributed either to lack of common professional knowledge, to neglect of duty, or to a desire to economize. The ability of the two engineers was tried in one of the most difficult professional problems of the day and proved to be insufficient.

"(g) We do not consider that the specifications for the work were satisfactory or sufficient, the unit stresses in particular being higher than any established by past practice. The specifications were accepted without protest by all interested.

"(h) A grave error was made in assuming the dead load of the calculations at too low a value and not afterwards revising this assumption. This error was of sufficient magnitude to have required the condemnation of the bridge even if the details of the lower chords had been of sufficient strength because, if the bridge had been completed as designed, the actual stresses would have been considerably greater than those permitted by the specifications. This erroneous assumption was made by Mr. Szlapka and accepted by Mr. Cooper and tended to hasten the disaster.

"(i) We do not believe that the fall of the bridge could have been prevented by any action that might have been taken after August 27, 1907. Any effort to brace or take down the structure would have been impracticable owing to the manifest risk of human life involved.

"(j) The loss of life on August 29, 1907, might have been prevented by the exercise of better judgment on the part of those in responsible charge of the work for the Quebec Bridge and Railway Company and for the Phoenix Bridge Company.

"(k) The failure on the part of the Quebec Bridge and Railway Company to appoint an experienced bridge engineer to the position of chief engineer was a mistake. This resulted in a loose and inefficient supervision of all parts of the work on the part of the Quebec Bridge and Railway Company.

"(l) The work done by the Phoenix Bridge Company in making the detail drawings and in planning and carrying out the erection, and by the Phoenix Iron Company in fabricating the material was good and the steel used was of good quality. The serious defects were fundamental errors in design.

"(m) No one connected with the general designing fully appreciated the magnitude of the work nor the insufficiency of the data upon which they were depending. The special experimental studies and investigations that were required to confirm the

judgment of the designers were not made.

"(n) The professional knowledge of the present day concerning the action of steel columns under load is not sufficient to enable engineers to economically design such structures as the Quebec Bridge. A bridge of the adopted span that will unquestionably be safe can be built, but in the present state of professional knowledge a considerably larger amount of metal would have to be used than might be required if our knowledge were more exact.

"(o) The professional record of Mr. Cooper was such that his selection for the authoritative position that he occupied was warranted and the complete confidence that was placed in his judgment by the officials of the Dominion Government, the Quebec Bridge and Railway Company, and the Phoenix Bridge Company, was deserved."

APPROXIMATE ESTIMATES IN CONTRACT WORK.

A DISCUSSION OF THE NECESSITY FOR THE ESTABLISHMENT OF A FIXED STANDARD OF APPROXIMATION FOR THE PROTECTION OF BOTH PARTIES.

Alexander Potter—Ohio Engineering Society.

THE approximate estimates on which bids on contract work are asked have probably given rise to more trouble and litigation between engineers and contractors than any other element in the specifications. When the estimates of the work to be done are truly approximate, that is very close to the actual amount, they serve a very useful purpose in affording a fairly accurate basis for the comparison of unit-price bids; but the uncertainties of estimation in some classes of work are so great that, besides leading to misunderstandings between the two parties to the contract, the estimates given as approximate in the specifications often defeat their own purpose in leading to the selection of a bid which would not have been the lowest had the competition been based on accurate figures. In a paper read recently before the Ohio Engineering Society, reprinted in *The Engineering Record* for February 22, Mr. Alexander Potter suggests that, for the protection of both parties to the contract, the unit prices bid on the estimates should not prevail when the quantities actually involved in the work vary from the approximation by a certain fixed percentage made a part of the contract. The following extracts give an outline of Mr. Potter's argument.

"The powers and responsibilities conferred upon an engineer in connection with public work are often vastly greater than even the engineers themselves believe or realize to be the case. The importance of setting before the contractor proper and accurate data and estimates is something the engineer must not lightly consider. If the engineer has any thought that the specifications and estimates do not represent the actual future conditions, clauses should be inserted in the contract that will give the contractor the right to demand that, for unreasonable discrepancies, the work shall be paid for at cost plus a reasonable margin of profit. This may to a certain extent suggest an innovation in the manner of letting contracts, but I believe that it is the only fair and just thing to do and will in the end save not only trouble and litigation, but be a financial saving to the communities or companies adopting it.

"Under the average specifications the engineer is not only a court of last resort and final arbitration, with powers of final decision specifically delegated to him, but he is also in reality the attorney for the defense, for the reason that he has either himself prepared all the important and vital clauses of the contract and specifications, or has inserted them from contracts which other engineers have previously prepared. It is customary for the legal representatives of the city or company letting the contract to have little to do with the preparation of technical contracts and specifications for construction work, merely passing upon the correctness of their legal form, and not at all upon their subject matter and requirements.

"The engineer is also practically a defendant in matters of dispute arising between his employer and the contractor, because it is upon the correctness of his estimates that the work is based. On this account the tendency is very strong and the temptation very great for the engineer

to endeavor to make good his estimates by minimizing as much as possible the difficulties met in the construction of the work by endeavoring to force the performance of work which had clearly never entered into the mind of the engineer or the contractor when the contract was signed. Had it been foreseen the contractor would never have taken the contract under the conditions specified, and the engineer, had he known of such conditions being present, should have forewarned the contractor or given notice of them in his approximate quantities.

"Contracts written with double or uncertain meanings, evasive clauses, or unjust and arbitrary assumptions of power, in the end bring no credit upon the engineer who writes them, nor profit to the corporation in whose favor they are enforced. There are of course allowable and unavoidable variations in contracts and approximate estimates.

"In the fabrication of steel, in the manufacture of machinery, and in the erection of the superstructures of buildings, there are but few and minor elements of chance which would interfere with a contractor giving such an intelligent bid that, provided his bid is a balanced bid, no harm can come either to the city or corporation or to himself by reason of a large discrepancy between the approximate estimate advertised and the amount of work which the contractor is called upon to actually perform, saving only the fluctuation in the price of labor and materials. But in all work involving the uncertainties of excavation of any sort, whether it be in earth, quicksand, or rock, such as is encountered in the construction of reservoirs and dams, water-works, sewers, railroads, canals, docks, or deep foundations, the actual cost of the work may differ very materially from what either the engineer or the contractor assumed the work would cost when the contract was entered into. The actual cost of removing earth and rock is in many cases from 50 to 200 per cent. greater than the engineer deemed at the time to be fair unit prices for such work. In other cases the actual cost of performance of work has often proved to be from 50 to 75 per cent. less than the price bid upon the work, which price was based upon the best information available to the contractor at the time the bid was prepared.

"Often, as the work advances, the actual conditions develop a state of things which proves that the information given in the first instance was entirely misleading. On this class of work, therefore, it is seen how important it is to have the approximate estimate of quantities approach the actual quantities which are to be required to be done as closely as possible, for if on the one hand the contractor has been led to believe that there is a certain amount of material to be handled and he is being greatly overpaid for the work performed, it is not fair to the city or corporation for which the work is being done, that it should be compelled to pay such excessive prices upon an amount greatly in excess of the advertised quantities and on which the contractor estimated his profits. While on the other hand, if the contractor has agreed to the performance of work at a price which is grossly inadequate, under the honest misapprehension of conditions, it is unfair, under the omnibus clause in the contract providing for variations, additions, and changes, to compel him to perform work greatly in excess of the quantities upon which he was willing to risk his judgment and his capital as to the value of work.

"The limiting of the words 'approximate estimate' to mean a quantity within a reasonable percentage above or below the amounts called for will tend to much more intelligent bidding, and also to the eradication and elimination of much of the trouble and litigation now occupying the courts of this country, due to the involuntary fraud upon or on the part of cities permitting or compelling contractors to perform work at absurdly high or absurdly low prices upon amounts which neither the engineer nor the contractor dreamed he would be called upon to perform at the time of the signing of the contract.

"There should be no difficulty in inserting clauses in specifications providing that when the approximate estimate shall have been exceeded by a certain predetermined percentage, the unit prices bid upon the work shall no longer prevail, but that the balance of the work shall be performed at cost to the contractor plus a reasonable percentage for profit on labor and material.

"Under the ordinary form of contracts the engineer is now empowered to make any such changes as he may see fit in the work. In other words, he is given such extraordinary powers of control over the contractor, that the contractor can hardly object to having delegated to the engineer the determination of what this extra cost shall be; and the city or corporation having already placed in the hands of the engineer the responsibility of conducting its work, should have no objection to vesting him with this small additional power. The writer can conceive of no difficulties arising from such a restrictive clause as that mentioned, but believes that in the end the adjustment of all inequalities under the contract, and provisions for settling them would tend to lower the cost of contract work generally."

THE CORROSION OF STEEL.

AN EXPLANATION OF THE ELECTROLYTIC THEORY OF THE CAUSES OF CORROSION IN IRON AND STEEL.

Allerton S. Cushman—Journal of the Franklin Institute.

VARIOUS theories to account for the corrosion of iron have been put forward from time to time, but the weight of evidence seems to be strongly in favor of the most recent, the electrolytic theory, which is coming to be generally accepted. The experimental investigations on which the theory is based and its explanation of the phenomena of iron rusting are so comprehensive as to make its satisfactory presentation in short form a difficult matter. In the *Journal of the Franklin Institute* for February, however, Dr. Allerton S. Cushman, whose experimental work in the Department of Agriculture has contributed so largely to the formulation and verification of the theory, has presented in a short space a very clear and interesting outline of its main points, which we reproduce in abstract below.

Chemically speaking, structural iron or steel is not a standard substance, but varies in composition and in character. Absolutely pure iron has but a limited application in industry and the properties sought in the structural material are produced by the presence of other elements. The extent of the changes made in the chemical and physical properties of iron by the addition of even very small amounts of impurities is one of its most remarkable characteristics. A variation of a few tenths of one per cent. of carbon or a few hundredths of one per cent. of phosphorus may make all the difference between the suitability and uselessness of a steel for a given purpose. Sulphur, silicon, and manganese are other elements whose presence in extremely small amounts produce important differences in character.

Resistance to corrosion is one of the most variable characteristics of steel. Not only do the various kinds of merchant iron vary within wide limits in this regard but specimens from the same mill or furnace will often show great differences. The prevention of corrosion is of the greatest importance to the engineer and architect. Owing to the affinity of iron for oxygen absolutely unrustable steel is probably impossible of production but with a proper knowledge of its causes, the danger of serious corrosion may be removed during the processes of manufacture.

The electrolytic theory of the corrosion of iron is the one now most generally accepted. In modern chemical theory all reactions which take place in water are attended by certain readjustments of the electrical states of the reacting particles which are called ions. Under the atomic theory the molecules of compound substances are made of atoms held together by a force or forces which represent large amounts of energy. Some substances when dissolved in water will conduct electricity while others will not. The former are called electrolytes and include inorganic acids, alkalies and salts. The latter substances or non-electrolytes, are for the most part inorganic bodies. According to Arrhenius' theory of electrolytic dissociation, the molecules of electrolytes as they pass into solution in water, dissociate into ions, which are simply atoms carrying, in spite of the smallness of their mass, very heavy charges of electricity. That no energy may be lost or gained, the dissociation must produce both positive and negative ions, which are equivalent and opposite.

To illustrate this theory of solution the case of sodium chloride or common salt is taken. When salt is mixed with water it tends to go into solution owing to a force known as solution pressure. As solution goes on a back pressure, known as osmotic pressure is exerted, which to a constantly increasing extent resists the entrance of more molecules, and the solution process ceases when the solution pressure and the osmotic pressure are in equilibrium. In passing into solution the salt dissociates into its constituent sodium and chlorine ions carrying equal and opposite charges of static electricity. Osmotic pressure acts against the dissociation pressure also and in concentrated solutions an equilibrium is established between these two forces as well.

This solution theory offers the explanation of the rusting of iron. It is well known that if an iron plate is immersed in a solution of a copper salt, iron goes into solution and copper is deposited on the iron, on account of the fact that the solution pressure of the iron is greater than that of the copper ions. A similar reaction occurs when iron is immersed in pure water. Even the purest water is to a certain extent dissociated and contains positive hydrogen and negative hydroxyl ions. Hydrogen acts as a metal, and since it has a solution pressure slightly less than that of iron, the latter passes into solution in exchange with the hydrogen.

"It has been shown experimentally that iron cannot at ordinary temperature combine with oxygen unless the iron first passes into solution and it is apparent from this that the initial cause of rusting is not oxygen, but hydrogen bearing a static electrical charge, in other words, the hydrogen ion. Now all acids derive their character from the fact that they dissociate in solution with the production of hydrogen ions, and this is the reason why all acids stimulate the corrosion of iron. On the other hand, alkalies dissociate in solution with the production of hydroxyl ions, which by the reverse action already explained neutralize and remove the hydrogen ions and thus inhibit rusting.

"It is well known to engineers that sulphurous acid, as well as carbonic acid, from coal smoke produces rapid destruction of steel, whereas alkaline cements, mortars, and concretes will preserve steel imbedded in them so long as the reaction remains sufficiently alkaline. The only cases recorded in which steel is said to have corroded when imbedded in concrete, are those where percolating water under pressure has washed away the free lime and thus removed the alkaline reaction."

The role of oxygen, however, though secondary, is important. Iron exists in combination with oxygen in two states, the state of lower oxydization being called ferrous, and the higher, ferric. Oxygen always changes ferrous to ferric compounds. When the iron, therefore, appears in solution in the ferrous state, it is at once attacked by the oxygen of the air and precipitated at the point of attack as the insoluble hydrated ferric oxide known as rust. By this precipitation the iron ions are destroyed and removed from the solution and the consequent lowering of the osmotic pressure permits the formation of more iron ions to take the place of those precipitated.

As rusting proceeds the solution of the iron does not take place uniformly over the exposed surface but is stimulated at certain points and inhibited at others. This can be explained in only one way, namely, that local electrolysis is taking place. The effects of this direct local electrolysis are to be seen in the pitting which is almost always observed when iron and steel are deeply rusted. Experiment has proved that corrosion is always due to this local electrolysis on the surface of the metal itself with the establishment of positive or negative spots or areas. It is from the recognition of this fact that we may look for the improvement of conditions as they exist at present.

"It follows from what has been said that the more carefully lack of homogeneity and bad segregation are guarded against during the process of manufacture the less likely is the metal to suffer from rapid corrosion. If the iron contains metallic impurities dissolved in it, such as manganese, which differ electrochemically from iron, trouble is sure to ensue if there is a lack of homogeneity in the distribution of the impurity. In the old days when the iron was made more slowly and received more careful working than is possible than in the present day, corrosion was not the important problem it has since become.

"It would follow from the electrolytic theory that in order to have the highest resistance to corrosion a metal should either be as free as possible from certain impurities or should be by careful working and heat treatment rendered so homogeneous as not to retain localized positive and negative nodes for a long time without change.

"Manganese is an element which is almost always associated in modern metallurgy with iron and steel owing to the fact that this element is used as a flux in the great processes used to-day for changing cast iron into steel. Manganese however, increases the electrical resistance of iron and as the percentage of this element, starting from zero, rises, the electrical resistance of the metal increases up to a certain specific maximum. Now, you will see, if the dissolving of manganese in iron raises the electrical resistance, that any changes in the equilibrium or distribution of the manganese in the metal means that there will not be an even or homogeneous electrical conductivity throughout the mass.

"If we have a metal in which the electrical conductivity for any reason varies from point to point on the surface we have the precise conditions which are necessary in order to establish the local nodes of electrolytic action on the surface which lead to rapid corrosion. It is apparent, therefore, that if we are to allow the presence in structural steel of comparatively high percentages of metallic impurities, such as manganese, we must attempt to obtain an extremely homogeneous distribution of such impurities. It is for this reason principally, in the opinion of the writer, that the more quickly and more carelessly the metal is manufactured and rolled, the more quickly it disintegrates under corrosive influences. As has been pointed out before, there are two methods of meeting the problem: first, to keep the percentage of metallic impurities as low as possible, and secondly, to guard against segregation and imperfect chemical homogeneity in the metal. In experiments we have made looking to the manufacture of a corrugated steel culvert for use in road building, it has been found by the author that corrugated metal, running as low as .04 manganese, has been more resistant to the corrosive test employed than the ordinary steel of the day, which usually carries about .5 per cent. manganese. Material of this kind has not been available for a sufficient length of time to determine whether under service conditions this low manganese metal will be longer lived, but it can safely be stated that the indications are all in its favor.

"The writer has urged the manufacture of manganese-free steel for certain purposes, not because manganese is necessarily the cause of rapid corrosion, but because this impurity enables the metal to be rolled more easily and more cheaply, and in many cases permits the working in of large amounts of heterogeneous scrap. It is possible to manufacture shoddy steel as well as shoddy cloth, and though both of these materials have their legitimate uses for certain purposes, no one will claim for them high resistance to disintegrating influences. It is a hopeful sign of the times that manufacturers are beginning to pay serious attention to the manufacure of iron and steel for certain purposes which shall be to the highest possible degree rust proof.

"In conclusion it may be said that there is reason to hope that the time is not far distant when specifications may be drawn for material that is going into service under conditions which make it particularly subject to corrosive influences. The possible added cost of such specially resistant metal will be small in comparison to the benefits which will be derived from its use in the long run."

THE DESTRUCTION OF TAR IN GAS PRODUCERS.

A DISCUSSION OF THE EFFICIENCY AND PRACTICABILITY OF THE VARIOUS POSSIBLE METHODS.

H. P. Bell—Engineering.

ONE of the most important problems in connection with the extension of the application of gas power is the development of a bituminous producer which will supply gas free from tar. It has been stated recently in a contribution to this magazine that the bituminous producer working in conjunction with an elaborate gas-cleaning plant will give satisfactory service, but the considerable cost

and the necessity for careful supervision of such an installation will undoubtedly prevent the general adoption of bituminous coal for gas production so long as supplies of anthracite are available for use in the more simple suction producer. The subject of bituminous producers which will, in themselves, destroy the tar produced was discussed comprehensively by Mr. H. P. Bell in *Engineering* for January 31 and February 7, 1908. We have space in this brief abstract to present only the more important of Mr. Bell's comments on the elements of the problem and the principles on which it must be solved, without touching his extended review of the various producers which have been designed or suggested as likely to fulfil the requirements of the problem.

The advantages of bituminous coal over anthracite or coke include not only its cheapness and the wide area over which it can be obtained but also the enrichment of the gas by its volatile constituents. These latter vary considerably both in quality and quantity, but in general it may be said that the calorific value of the gaseous hydrocarbons distilled from bituminous coal is about 20 per cent. of the total calorific value of the coal. While the total quantity of heat in the gas produced from bituminous coal may be no greater than that from a similar quantity of anthracite or coke, this heat is carried in a smaller volume of gas, a consideration which is, in many cases, of considerable importance. In fact the use of bituminous coal should result in increased economy in gas making, since the distilled gas is produced with a less expenditure of heat than the gas from an equivalent quantity of carbon. The aim of designers of bituminous producer plants should be either to produce a richer gas with no decrease in economy, or an increased economy with no loss in calorific value. In the future, producer gas will have to make its way chiefly as a gas made from bituminous fuel.

Most of the difficulties in bituminous producer operation have been solved more or less successfully in connection with anthracite producers. The distinctive feature of bituminous coal, the large quantity of tar carried over with the gas, however, presents a new problem and one of considerable difficulty. This tar frequently amounts to 4 or 5 per cent., and may reach 15 per cent., of the coal. Its separation from the gas before the latter reaches the engine cylinder is a matter of necessity and the size and cost of the plant for the efficient cleaning of the gas have been the principal deterrent causes of the slow extension of the use of the bituminous producer. The problem of tar destruction, however, differs from that of gas cleaning.

"There are two practicable methods by which tar may be destroyed: complete combustion with air, and decomposition at a high temperature. In the first case, that of complete combustion, the products—carbonic acid and water vapour—must, for the sake of economy, be reduced to carbon monoxide and hydrogen by passing them over hot coke. In the second case the tarry vapours are passed directly over hot coke, or through heated regenerators, and are thereby broken up into, on the one hand, gases such as marsh gas, ethylene, etc., with carbon monoxide and hydrogen; on the other hand, into heavy hydrocarbons and carbon. The heavy hydrocarbons are for the most part burnt with the coke, so that the general statement is approximately true, that the tarry vapours are decomposed into fixed gases and carbon.

"'In favour of the first method it has been urged, on the one hand, that it is only by combustion that the tar can be completely destroyed, but this involves the separation of the whole of the tarry vapours, which is hardly possible, since even gas made from coke contains tar. On the other hand, this method must result in impoverishing the producer gas, since the volatile gases of the coal are burnt with the tarry vapours; so that with a really efficient plant working on this principle the final gas will consist only of carbon monoxide, hydrogen, and nitrogen, just as if the gas were made from entirely non-bituminous fuel. This method, then, while it may go far towards overcoming the defects, takes no advantage of the merits of bituminous fuel. The second method preserves most of the valuable distilled gases, and consequently yields a richer gas, even if the destruction of tar is less perfect. In any case complete destruction of tar is hardly practicable even under experimental conditions; some kind of cleaning plant will always be required—at any rate, if the

gas is to be used in internal-combustion engines, and the most that can be looked for is a reduction of this plant to the smallest possible dimensions.

"In both methods the gases or vapours are passed through hot coke, and it is therefore necessary to provide for the maintenance of a temperature high enough to effect the required chemical actions, and of a column of coke long enough to make these actions complete. If, as is usually the case, the temperature is maintained by mixing air with the gases as they pass through the coke, some combustion of the gases with the air will occur; the desired reduction will only go as far as a point of equilibrium, depending on the proportion of air present, and the resulting gas will contain more or less carbonic acid and water-vapour due to this combustion. It is therefore desirable to keep as low as possible the quantity of air which is allowed to come in contact with the hot gases."

Mr. Bell then proceeds to a description and discussion of the construction and operation of the many producers which have been designed with a view to the destruction of tar, grouping them roughly according to their arrangement and manner of operation. He says, however, that "a more rational classification depends upon the actual processes which take place in the producers, which fall naturally into three classes. In the first class are those producers in which tar is destroyed by more or less complete combustion. In the second class are those which effect a compromise between the processes in the producers in the first class and the processes in the producers of the third class, in which last there is no secondary combustion, and tar is destroyed only by contact with hot coke." Concluding, he says:

"It may be conceded that the method of decomposition without combustion cannot effect the destruction of the whole of the tar from bituminous coal; it seems evident from what has already been said that such complete destruction is very difficult even by the method of combustion, and it is practically certain that really complete destruction has never been achieved with any kind of producer-plant. The tar may be so reduced in quantity that only a small purifying plant need be used, but there is little doubt that in some cases too small a purifying plant is provided. A considerable length of gas-main is not quite inefficient as a purifying apparatus, and it sometimes has to serve this purpose. The tar-destroying efficiency of a producer plant must, therefore, be judged by testing the gas as it leaves the plant, not at the engines, which may be some distance away. It is obvious that, if the combustion of the distillates is incomplete, it will be confined to the fixed gases, which are the most useful, and the lighter hydrocarbons, which are the least objectionable of the distillates; the heaviest hydrocarbons, the presence of which is the most serious drawback to the use of producer gas, will be the last to be burnt.

"The method of simple decomposition of tar has the advantage which must be set off against any deficiencies in tar-destruction, that the gaseous hydrocarbons, which are distilled from bituminous coal, are not destroyed, and that their quantity is actually increased by the addition of similar compounds resulting from the decomposition of the tar. Besides this, the proportion of nitrogen in the gas can be kept to lower limits, owing to the fact that no air is used for secondary combustion, and the generation of sensible heat need be no greater than is necessary for the chemical actions which have to take place in the producer, and for the inevitable losses by radiation and conduction.

"It is quite likely that no one type of producer can be devised which will be the most suitable for all purposes, and the same may be true of methods of tar-destruction. For purposes, however, for which freedom from tar is important, calorific value is usually also important, and for all heating purposes gaseous hydrocarbons are as suitable as any other gas. It has been said that poor gas is better adapted than rich gas for use in internal-combustion engines, because it is more capable of standing high compression without premature explosion. As a general statement this is not true, though it is true if enrichment of the gas can only be carried out by the addition of hydrogen. Explosion engines require a gas with a high flame temperature, for which a high calorific value is necessary, and producer gas enriched by the addition of hydrocarbons distilled from coal is quite

capable of standing high compression without any very serious danger of premature explosion.

"A process which results in the destruction of tar in bituminous coal places such fuel on equal terms with non-bituminous coal for the production of power-gas; a process which results in the conservation of the gaseous hydrocarbons, and the consequent production of a richer gas, gives the bituminous a distinct advantage over the non-bituminous coal. It seems then a wise policy to aim at a method of gas-production which will, so far as possible, combine both these processes, and it is likely that the use of some such combination will provide the most profitable method of producing a power-gas free from tar."

THE APPLICATION OF SCIENCE TO FOUNDRY WORK.

THE NECESSITY FOR THE APPLICATION OF METALLURGICAL AND CHEMICAL SCIENCE TO THE PURCHASE OF PIG AND THE PRODUCTION OF CASTINGS.

Robert Buchanan—Royal Society of Arts.

CONDITIONS in iron founding have improved greatly within the last few years and it is no longer true that foundry practice fails to show improvement comparable with the advances in other branches of the iron industry. According to a paper by Mr. Robert Buchanan, read before the Royal Society of Arts on February 12, 1908, however, a great deal still remains to be done and the uncertainties and difficulties of foundry work can never be overcome until the principles of metallurgical and chemical science are applied generally, both to the purchase of materials and to the production of castings.

Mr. Buchanan first discusses materials and processes for the making of molds and methods of melting. Passing then to the mixing of iron for the furnace, he says:

"The mixing of iron on scientific principles is of very recent origin, but is being practised more and more by progressive, because better educated, foundrymen. Unfortunately, there exists in this as in other countries, a large number of men in charge of foundries who, however skilled they may be in the ordinary routine work of a foundry, have not had the training, nor have they the knowledge, of how to apply chemical and metallurgical principles. This, for them, unfortunate position puts them into endless difficulties if they have to leave the beaten track of 'use and wont.' Where special strength or hardness or softness is required, they have to depend on brands of iron which in the course of years have obtained a reputation for the particular quality desired. They are not aware that the particular qualities of an iron depend upon its chemical constitution, and that no make of pig-iron is always of the same quality. Indeed, some pig-irons which have the same brand as they had 20 years ago are now made from quite different ores. Hematite iron, usually considered by foundrymen as the purest iron they can use, is often worse than ordinary pig-iron in respect of sulphur. These have been rejected by steel makers on that very account, and are passed on to the ironfounder of a larger faith in continuity of quality.

"Such things would not be possible were iron foundries generally run on strictly scientific lines, as are all steel works and most blast furnaces. The blast furnacemen themselves buy iron ores and coke, subject to suitable analyses, but most of them have a marked disinclination to sell their iron to analysis. They prefer selling their iron by the well-known system of numbers—1, 2, 3, and so on—but no one has yet defined what any one of these numbers is meant to convey. In the whole domain of metals there is nothing so unscientific as this system of selling and buying pig-iron by numbers. The blast-furnacemen have objected that, did they sell to analysis, most foundrymen would not know how to use the iron when they got it. That is perfectly true of many foundrymen at the present time, but were they confronted with the difficulty, of which unfortunately there is no immediate probability, they would perforce have to study the metallurgy of cast-iron with the greatest possible resulting benefit to themselves, and to the industry in which they are engaged. At the present time, only the very large firms, whose volume of business must be secured, are en-

abled to buy to an analysis. Once these firms have used analysis in the purchase and use of their foundry materials, nothing would induce them to revert to old methods of purchase and of use which are haphazard in the extreme. In a word, foundries using scientific methods of work find that they pay handsomely.

"Before a foundryman can use scientific methods in his work, it is obvious that he must have some training in, at least, elementary chemistry and metallurgy. I have heard a very successful teacher of metallurgy say recently, that the number of foundrymen attending the classes had increased largely within the last two years. This is a most encouraging fact for those interested in the advance of the industry.

"When one begins to apply scientific principles to the mixing of iron in the cupola, a profound knowledge of the metallurgy of cast-iron is not necessary. A knowledge of the principles governing combustion, the function of fluxes, such as limestone, to form suitable slags, and the influence of the various constituents of cast-iron so far as they affect the general body, will do for a beginning. I have heard it said that a certain noted metallurgist, after making over three thousand tests, with iron containing varying proportions of carbon, stated that he did not know anything about the influence of carbon on iron.

"In the case of cast-iron we have not only carbon to consider, but also silicon, phosphorus, sulphur and manganese. These may naturally be thought to complicate and render more difficult the study of this metal. Each of the elements named may be helpful to the founder under one set of conditions and hurtful under other conditions. The ironfounder, using scientific principles, uses only those which serve his purpose. Before he can do so he must understand what they are going to do for him, favorably or adversely, when he has in view the production of a particular quality of iron. By doing so, he puts aside all questions of brands and numbers of pig-irons, and forms his new compound in exactly the same way as the chemist does his. Each deals with elementary substances which combine in certain definite proportions. Beyond this, however, the ironfounder has to consider the changes which take place when melting the iron, and also the influence which size of casting has upon the ultimate product, owing to fast or slow cooling."

The amount and condition of the carbon in cast iron is almost wholly controlled by the other constituents present. When silicon is in excess the carbon content is low and is nearly all in the graphitic form. Low carbon produces a soft iron liable to "sink" in local heavy parts. It also tends to increase contraction owing to the fewer number of graphite flakes which occupy more space than the combinations of carbon and iron. Castings with much graphite are both soft and weak since the flakes of graphite assist the tearing asunder of the particles of iron. Combined carbon and graphitic carbon may be made practically interchangeable under suitable conditions. The presence of sulphur, the absence of silicon and quick cooling will cause most of the carbon to take the combined form, while low sulphur, high silicon and slow cooling will produce graphitic iron. The hardness of cast iron increases with the amount of combined carbon present and, until the latter reaches about 0.6 per cent., the strength increases also.

Up to 4 per cent. silicon acts as a softening agent by causing the carbon to take the graphitic form. Above this percentage it acts as a hardener. The most important function of silicon is in increasing the power of the iron to dissolve gases. It is thus of great value as a preventative of porosity in castings.

Manganese has the property of neutralizing sulphur, which it carries into the slag. In itself it is a hardening agent but by its action on sulphur it may act as a softener, since sulphur has a hardening effect. Manganese increases the power of iron to dissolve carbon, but its action is not so powerful as that of silicon in the opposite direction. It is distinctly beneficial in that it prevents the oxidization of iron and silicon during melting.

Phosphorus has a marked influence on the rapidity and cost of melting. It lowers the melting point of iron and gives it a fluidity which makes it easy to cast. Beyond this, however, its beneficial effect does not go. Castings high in phosphorus are very brittle and do not readily resist shock. The proportion should not rise above 0.2 to 0.4 per cent. when great strength is re-

quired, though for fluidity combined with fair strength 0.7 to 0.9 per cent. is permissible.

The influences of sulphur are almost wholly deleterious and are the most difficult against which the foundryman has to contend. The proportion of this element in pig iron should never rise above .06 per cent. but since the sulphur content of pig is dependent on conditions in the blast furnace, the foundryman can protect himself only by purchase by analysis. Sulphur produces a hard iron by making the carbon take the combined form; it increases contraction and makes the casting liable to crack on cooling; and it is liable to cause unsoundness by the production of gases just at the setting point of the casting. It may be rendered inert by the use of manganese, suitable fluxes in the cupola, and very high temperatures, but the foundryman has very little power to lessen its effects. So far as possible its entrance into the cupola either in the iron or coke, must be prevented.

"Having dealt at some length with the constituents of cast-iron and the particular influence which each exerts upon the general body, we now proceed to ascertain to what degree they are affected during the melting of the iron. This is necessary to be known before we can predict what the constitution of the iron in the casting will be. To be able to predict what the constitution of the casting will be, and be able to make one's predictions come true, are only possible when using scientific methods in mixing the iron.

"When melting iron in the cupola, the constituents are altered as follows, each time the iron is melted, the sulphur in the coke being taken as 0.70 per cent.:

	Per cent.
Sulphur	gains 0.038
Manganese	loses 0.100
Silicon	loses 0.250
Phosphorus	unchanged

"Knowing the analyses of the various irons which it is proposed to use in the mixture, adding together each constituent, and adding or subtracting each gain or loss made during melting, one gets wonderfully accurate results."

THE CONTINUOUS TESTING OF GAS.

A DESCRIPTION OF A DEVICE PROPOSED FOR THE CONTINUOUS DETERMINATION OF THE CALORIFIC VALUE OF GASES AND GASEOUS MIXTURES.

M. A. Adam—Revue de Métallurgie.

IN the *Revue de Métallurgie* for January, 1908, M. A. Adam proposes an interesting device for the continuous determination of the calorific value of gases and gaseous mixtures for the operation of gas engines and the firing of furnaces and boilers. It is only by proper proportioning of the mixture that the highest economy and efficiency in these applications of gas can be secured and the problem is, both theoretically and practically, one of the most important connected with the use of gas as a motive power or heating agent. Such a device as M. Adam proposes should be of great advantage, especially in the case of blast-furnace gas, to which he particularly refers, on account of its variable quality.

In the use of gas as a fuel for gas engines or furnaces there is one mixture which is more efficient than all others. The character of this mixture depends on the calorific value of the gas, the pressure and temperature, and the humidity of the air and the gas. On account of the constant variations in the quality of the air and gas, the mixture is undergoing constant change, and in a manner particularly important in the use of lean gas in gas engines and furnaces. The lack of some device by which the proper mixture can be determined at each moment has long been recognized as a marked deficiency in the management of these appliances.

In the firing of furnaces the appearance of the flame gives a certain amount of information and a certain amount of regulation can be accomplished in connection with analyses of the burnt gases. In gas engine operation Watt's indicator gives sufficiently precise information as to the composition of a mixture, but the taking of diagrams is not always possible and they must be taken at short intervals to be of any use. The method is not practicable. By testing, an engineer can usually arrive at an ac-

ceptable mixture, that is, one which will turn the engine at its normal speed and furnish the necessary power, but this approximate result is still insufficient. Not only is it uneconomical, but the mixture may be established at the limiting condition of operation of the engine, and a variation of the qualities of the air or gas, an excess of air or gas, or even a sudden demand for power may then suffice to stop the engine. A poor mixture is often the cause of stoppage of single-cylinder machines.

Some form of continuous testing device is, therefore, desirable, and it would seem from the following considerations that its design should not be a difficult matter. If we consider a burner supplied with a practically constant volume of mixture in which the ratio of gas and air can be varied at will, it is evident that the best mixture will be that which will give at the burner the highest flame temperature. By placing in the flame a thermo-couple connected to a galvanometer this most efficient mixture can be determined by observing the fluctuations of the galvanometer during manipulation of the gas and air cocks regulating admission to the burner.

In applying this principle to the determination of the best mixture for use in gas engines, it is necessary to have at the burner exactly the same conditions of mixture as exist in the engine cylinder into which the mixture enters on account of the vacuum produced by the suction stroke, the air at atmospheric pressure, and the gas at the pressure, generally variable, of the distributing conduits. This condition is fulfilled if the mixture to be burned at the burner is drawn into a small supply chamber during the period of admission to the cylinder or, better, during compression. By consulting the galvanometer during manipulation of the air and gas ports of the engine it is possible to obtain by this means the most efficient mixture. The best arrangement is to furnish the mixture to the motor in constant volume, but with a variable ratio of gas and air, by means of two valves with single control, regulated by watching the galvanometer, the regulation of the engine having for its object the admission of a quantity of the combustible gas in accordance with the demand for power.

It is possible that the mixture which is indicated by the galvanometer as the most suitable may not be found best for use in the engine on account of the influence of unrecognized phenomena. In such a case, a correction may be made by the taking of diagrams, first with an excess of air, and then with an excess of gas, the mixture indicated as best by the galvanometer being taken as the point of departure. The diagram of greatest area found by this method of trial will determine the mixture to be adopted.

It may be noted that, for a given admission, that is for a constant position of the regulator, the desirable means of control is always possible. The best mixture having been established for the mean position of the regulator at a time when the output of the machine is practically constant, it remains substantially the same for the other positions. The difference of speed plays only a small part in making very slight changes in the speed of admission of the gas. The only essential is that the regulator hold a fixed position during the regulation.

M. Adam says that a device embodying these principles could be arranged in a variety of ways. He illustrates one simple arrangement in which a small quantity of gas is taken from the engine cylinders during each compression stroke and conveyed to a small gasometer from which it is led under constant pressure to the burner, in the flame of which the thermo-couple connected to the galvanometer is placed. The burner, he says, could be eliminated by placing the thermo-couple within the cylinder, but in this case the variations of temperature during the four cycles would derange the readings and would necessitate the designing of a galvanometer which would register only the temperatures of successive explosions, without the position of the pointer altering for the small deviations.

In the case of furnaces, the furnace itself constitutes the burner and the thermo-couple can be placed directly in the flame, the air and gas valves being manipulated to produce the highest possible temperature. In them, as in engines, it requires only a few regulations of the mixture a day to secure the best possible working conditions.

DIAMONDS IN THE UNITED STATES.

A DESCRIPTION OF THE DIAMOND-BEARING PERIDOTITE DEPOSITS RECENTLY DISCOVERED IN ARKANSAS.

G. F. Kunz and H. S. Washington—American Institute of Mining Engineers.

PROBABLY no discovery of mineral in the United States in many years has aroused so much popular interest as the recent finding of a deposit of diamond-bearing peridotite near Murfreesboro, in Pike County, Arkansas. The deposit has been the subject of the misrepresentation common to all new mining fields and we are glad to present below an authoritative description of its character and extent, abstracted from a paper presented by George F. Kunz and Henry S. Washington at the February meeting of the American Institute of Mining Engineers.

To summarize briefly the geology of the deposit, "the igneous rock in which the diamonds are found is a vitreous peridotite, forming a stock or volcanic neck, which has broken up through the Carboniferous and Cretaceous quartzites and sandstones. After an extensive period of erosion, during which an unknown portion of the neck and presumably a previously existent volcanic cone have been removed, the surface was covered with thin beds of Post-Tertiary conglomerate. The volcanic intrusion was accompanied by the formation of several small dikes of a rock much like that of the main body. One of these dikes cuts across the stock, while another cuts the Cretaceous sandstone, but is overlaid by the conglomerate, thus giving a datum for the period of intrusion. So far as known, there was little, if any, metamorphism of the country-rock by the igneous magma, which probably followed an approximately vertical course, so that a more or less vertical extension downward of the igneous body to indefinite depths may be expected. This result should hold good, at least, for the upper and most accessible portions, though some departure from strict verticality may be expected at greater depths.

"As observed above, the igneous rock is a peridotite which, in fresh hand-specimens, is tough, hard, distinctly porphyritic, and very dark greenish or brownish-black. Microscopic study shows it to be composed of numerous crystals of olivine and some patches of biotite, imbedded in a groundmass of very small crystals of augite perofskite, and magnetite, with an abundant yellowish to colorless glass base. In all the specimens examined the olivines are more or less completely serpentinized, and the glass is apt to show an aggregate polarization due to decomposition. The rock is evidently an igneous intrusive, which probably welled up in comparative quiet, and solidified not far from the surface. It is therefore in no sense a volcanic breccia, due to explosive eruptions, as are most of the South African occurrences. Chemically and mineralogically, however, it much resembles the South African rock, although there are certain points of difference—notably the absence of inclusions."

The fresh rock is dense, hard and tough and does not crumble readily on exposure but the deposit exhibits the general tendency of peridotite to alteration by weathering. In the first stage of this alteration, the firm rock disintegrates into hard, angular fragments of various sizes, which do not themselves disintegrate readily on exposure. The second stage yields a compact mass of "green ground" which becomes yellowish in color on drying. The third stage, found nearer the surface, furnishes the "yellow ground," the color being due to further oxidation of the ferrous iron. Both the green and yellow grounds are soft and friable and crumble readily between the fingers. The fact that sharply defined, serpentinous pseudomorphs of the original olivine crystals are found in them, supplemented by the general appearance of the texture, show that the peridotite has been decomposed in place with little or no transportation of the material. Both the green and yellow grounds crush easily, when dry, to a fine powder from which the gritty particles of the less easily decomposed minerals can be sifted out; and when wet, to a fine mud which can be easily washed and concentrated.

Fresh, unaltered peridotite crops out in a few places and the product of the first stage of alteration is to be seen, but by far

the greater part of the igneous area is covered by the green and yellow ground. The maximum and average depths of the deposit of decomposed peridotites have not been exactly ascertained but the borings show it to be 40 feet thick in places and the average depth will probably be not less than 20 feet. Below this is found the compact or fragmentary igneous rock which runs to an unknown depth. Drillings to depths of 80, 186 and 205 feet have remained in peridotite to the end. The area known to be underlain by the peridotite is about 40 acres, while the surface exposure of the igneous area forms a rough ellipse with major and minor axes of 2400 and 1800 feet respectively.

"Up to the present time about 140 diamonds have been discovered within the igneous area, while none have certainly been found outside of it, even in the immediate vicinity. All the stones have been found on the surface, except two, which were in the concentrates derived from washing large amounts of the green ground, and one, which was imbedded in the green ground itself about 15 ft. beneath the surface. Our careful examination of this last specimen leaves no doubt that the diamond is actually in place in the rock and was not inserted in the specimen. Consequently it constitutes a definite proof that the peridotite is the source of the diamonds, and that all the stones so far discovered have been derived from it. It would be well, however, to have this single piece of evidence corroborated by similar specimens. With regard to the quantitative relations of the diamonds to the inclosing rock, about 200 carats have been found on or immediately beneath the surface, where presumably there has been considerable concentration of the stones. From the nature of the deposit, the average yield per ton can only be ascertained by actual washing or other extraction from the rock on an extensive scale, commensurate with that of purposed commercial operations.

"Additional factors of economic importance, for which more extensive data are necessary, are the average size, color and quality of the stones, since these factors determine their value. From the 200 carats at present available for examination, it appears that the Arkansas locality compares very favorably with most, if not all, of those in South Africa. Although no stones larger than 6.5 carats have yet been found, the average size is fairly good. There is a large proportion of white stones, for the most part of a high grade in color, brilliancy, and freedom from flaws. Indeed, many are as fine as have ever been found. Some of the yellow ones, also, are of exceptional quality and color."

The deposit is favorably situated for mining operations. Supplies of water, timber and coal are easily obtainable and the transportation facilities can be made adequate with little trouble. The labor problem will present the most serious difficulty, probably the most important consideration being the prevention of loss of diamonds by theft. Regarding the extraction of the diamonds, the green and yellow grounds are amenable to the method used at Kimberley for the treatment of this kind of material and will present no difficulty. The fresh and hard peridotite may present a more serious problem but probably not a more difficult one than has been solved successfully in South Africa.

"In view of the great local excitement over the discovery of diamonds which has extended over part of the State, and in view of the danger of the repetition here of the disastrous history of many mining camps which have undergone an unwarranted 'boom', and the consequent rush and loss of time and money by many innocent individuals, it should be distinctly understood by the public that the occurrence of diamonds near Murfreesboro is an isolated one, and that it does not resemble a mineral vein or lode in any respect. Consequently, there is not the least justification for any such claims as will undoubtedly be made by ignorant or unscrupulous parties, that 'a continuation of the vein' has been struck. There can be no continuation of a vein when there is no vein.

"Should other similar igneous areas, which may possibly be diamond-bearing, be discovered elsewhere, any claims put forward for them should be received with the greatest caution. Fortunately, the characteristics of the peridotite (in which, by analogy, diamonds may be most reasonably expected to occur) are so easily recognizable by a petrographer, the localities will be presumably so isolated, and the outlines and extensions of the mass so well defined,

that the report of a geologist or petrographer can surely prevent an unsuspecting or ignorant person from loss by investment in a property said to be a continuation of, or a connection with, the present deposit.

"Peridotites are not uncommon; but very few are diamond-bearing. Indeed, the great majority of these rocks found all over the world show no trace of diamonds. Even in South Africa, many peridotite pipes, resembling valuable ones, carry no diamonds, while in any given pipe some portions are found to be richer in diamonds than others."

BREATHING APPARATUS FOR USE IN MINES.

THE PHYSIOLOGICAL EFFECTS OF MINE GASES AND PRINCIPLES IN THE CONSTRUCTION OF BREATHING APPARATUS.

Leonard Hill—North Staffordshire Institute of Engineers.

AS an extension of M. Boyer's article on "Rescue Appliances in the Mines of France" on another page of this issue of THE ENGINEERING MAGAZINE we present the following abstract of an interesting and comprehensive paper on breathing apparatus read by Prof. Leonard Hill before the North Staffordshire Institute of Mining and Mechanical Engineers and reprinted in *Engineering* for January 17, 1908. M. Boyer describes the mechanical details of the leading devices used in France; Prof. Hill discusses the physiological effects of foul air on man and the general principles involved in the design of breathing apparatus.

The oxygen of the air of coal mines, owing to the processes of oxidization going on in the soil, undergoes continuous impoverishment. Pyrite in moist air is decomposed to form ferrous sulphate and sulphur dioxide. The latter combines with water to form sulphurous acid, which in its turn is oxidized to sulphuric acid and the sulphuric acid reacting with the carbonate of lime in the soil evolves carbonic acid. Pure choke or "black damp," as air impoverished by such processes is called, contains 85 to 95 per cent. nitrogen and 15 to 5 per cent. carbonic acid and is formed in enormous quantities. A frequent accompaniment is methane or fire damp which is given off by the coal. This gas is explosive in percentages above six per cent. but has no poisonous effect on man except in so far as it dilutes the oxygen of the air. The influence of deoxygenated air are, however, very serious. When the oxygen tension of the air falls below 17.3 per cent. of an atmosphere it becomes insufficient to support combustion. At 15 per cent., the effect on man is to produce slight dizziness and shortness of breath; at 10 per cent., respiration and pulse become more frequent; at 7 per cent., both mental and muscular power become impaired; and at a slightly lower tension consciousness is lost and life is in imminent danger. The most dangerous feature connected with work in an atmosphere undergoing gradual deoxygenation is that the discomfort felt is often slight and gives little warning of danger. Such an atmosphere should never be entered without breathing apparatus. With regard to breathing apparatus themselves, these effects of deoxygenated air make it essential that the gauge of the oxygen supply should be in a position visible to the wearer to prevent the possibility of an unnoticed exhaustion of the supply. On the other hand, an excess of oxygen is not without danger. An excess up to a tension of one atmosphere can be breathed with perfect safety for many hours, but long breathing of oxygen above this tension is likely to produce inflammation of the lungs, poisoning of the nervous system, and convulsions.

The effects of carbonic acid are less deleterious than is popularly supposed. Pure air contains only 0.03 per cent. of this gas, but an excess produces no noticeable effects until the proportion rises to about 3 per cent. This amount produces slightly more frequent respiration and pulse; 4 per cent., unpleasant panting; 6 to 7 per cent., marked difficulty in breathing; and 10 per cent., violent panting, throbbing of the arteries and flushing of the face. Tensions above 25 per cent. may cause death, but only after exposure for several hours. Probably no cases of carbonic acid poisoning ever occur for choke damp containing any large percentage kills by want of oxygen and not by excess of carbonic acid.

For comfort, however, it is necessary to keep the carbonic acid in breathing apparatus below 3 per cent. and advisable to keep it under 1.5 per cent., since many men suffer from headache after prolonged exposure to as much as 3 per cent. 1.5 to 2 per cent. of carbonic acid in the breathing bag is, however, a matter of no importance.

The most dangerous gas to contend against after a mine explosion is carbon monoxide which is always present, even though the mixture of gases seems to contain sufficient oxygen to sustain life. It is produced by the imperfect combustion of coal dust ignited by primary explosions of fire damp. Carbon monoxide unites with the haemoglobin of the blood and destroys life by robbing the body of oxygen. It is a poison only in so far as it is an oxygen robber. The danger in this gas lies in the particularly insidious nature of its action. When the blood is 20 per cent. saturated with carbon monoxide there occur dizziness and shortness of breath on exertion, but increasing saturation produces little additional sense of discomfort to warn the subject of the failure of his mental and physical powers. Anything above 0.15 per cent. in the air breathed is dangerous and 0.4 per cent. practically always will cause death. Owing to its insidious poisonous nature it is suicidal for a rescue party to attempt to face "after damp" without breathing appliances. To meet this peril such apparatus are absolutely necessary for the saving of life and the fighting of fire after mine explosions.

Breathing apparatus are also necessary to meet the dangers of hydrogen sulphide, an extremely poisonous gas, sometimes occurring in coal mines and almost always in stagnant sewers; and nitrogen peroxide, evolved in the accidental burning of dynamite or other gun cotton explosives, a slight exposure to which is likely to result in fatal inflammation of the lungs.

"The objects in the design of breathing apparatus are: (1) To allow the wearer to remain in an irrespirable or poisonous atmosphere for a period of time; (2) to do efficient work; and (3) to crawl through or under obstacles such as occur after a mine explosion, as much as possible with the same ease and safety as an unencumbered man. These objects are attained by connecting the mouth with a breathing-bag or box, into which oxygen is delivered, and from which the exhaled carbonic acid is absorbed; by making and arranging the required apparatus so that it is as light as possible, and is adapted to the body in such a way as to unfetter the movements of the wearer, and to increase the girth of the body as little as possible. The apparatus, too, must not project in such a way as to dislodge beams, rocks, etc., when the wearer is exploring dangerously encumbered ways after an explosion. The apparatus should fit him so that he knows he can pass through where his head and shoulders can pass. The apparatus must be air-tight from without inwards to prevent the entrance of irritating vapours, such as thick smoke, and the eyes must be protected from the same. In the case of after-damp, the latter protection is unrequired. It is of great value that the apparatus should allow of the mouthpiece being removed so that a few words of direction may be spoken or drink taken if occasion arises. There is no risk in doing this so long as the tube leading from the mouthpiece to the breathing-bag can be closed by the thumb.

"The breathing-bag must be large enough to contain the deepest inspiration or expiration quite easily. Inspiration out of an empty, or expiration into a full, bag is very distressing and not free from risk. The breathing volume while resting is about 500 cubic centimetres; while working it may reach 1500 cubic centimetres. The bag must be moderately distensible so as to act as a buffer or cushion for the ebb and flow, or inspiration and expiration.

"A man at rest requires on the average about 250 cubic centimetres of oxygen per minute, at work climbing hills 1200 to 1500 cubic centimetres of oxygen per minute. The use may rise to 2 litres per minute. This amount, therefore, must be continuously supplied, so that shortage can in no case occur, for it is very dangerous if the oxygen tension falls to less than 12 per cent. The breathing-bag should be washed out with oxygen when the wearer puts on the apparatus, so that it contains 60 to 70 per cent. oxygen. Diminution in volume of the breathing-bag will then warn the wearer by making inspiration difficult before the oxygen tension gets dangerously low.

"The carbon dioxide must be removed, so that the tension never rises to 3 per cent. It should be kept generally under 2 per cent., so as to avoid the chance of even slight discomfort.

"The dead space between the mouth and the inlet to the breathing-bag must be kept as small as possible, because the air in the dead space is breathed back into the lungs without purification. The dead space should not exceed 200 cubic centimetres at most.

"There must be some kind of gauge indicating the supply of oxygen. This gauge must be placed so that the wearer can see it, and thus time his retreat.

"It is most desirable that the apparatus should be constructed as simply and strongly as possible, so that it cannot get out of order when hung by in the store, and can be understood by an ordinary workman, and safely worn by him after no more than a few minutes' training. The apparatus, moreover, should be so designed that the man who is to wear it can put it on himself, without assistance, in the shortest possible time, and it should also be as light as possible."

Prof. Hill concludes his paper with a description of the modern form of the Fleuss-Siebe Gorman apparatus which has been under development and improvement since 1880. In Prof. Hill's opinion, this device satisfies all the requirements established by exact physiological data and combines the greatest simplicity and strength with maximum comfort and safety.

THE SAMPLING OF COAL MINES.

A DISCUSSION OF THE DISCREPANCIES LIKELY TO BE OBSERVED BETWEEN THE QUALITY OF SMALL MINE SAMPLES AND THAT OF THE REGULAR OUTPUT.

John Shober Burrows—Bulletin of the United States Geological Survey.

THE extensive fuel tests made at St. Louis during the past four years by the United States Geological Survey have not only added a large number of very valuable data to our knowledge of the conditions of efficiency and economy in boiler management but have produced also a most important body of information on a wide variety of subjects connected with the mining and preparation of coal. A recent contribution of the latter class, forming part of Bulletin 316 of the Survey's publications, deals with the subject of coal-mine sampling. The two factors which determine the value of a coal deposit are, first, the amount of workable coal available, and, second, the quality of the marketable product. The former can be ascertained by the ordinary methods of surveying and prospecting, but the latter is not so easy of determination. The usual method has been to take a small sample for chemical analysis from a freshly mined pile or car. The investigations of the Geological Survey have shown this method to be totally unreliable in that it usually produces a sample of coal much cleaner than that obtained in actual mining. The investigations have demonstrated clearly the necessity for uniform and systematic methods in coal-mine sampling and from them has been deduced a series of coefficients by which the results of analyses of carefully taken samples can be corrected to give a close approximation to the quality of the commercial product. When it is remembered that during the work of the Survey at least two mine samples and one or more cars of coal were taken from each of 159 mines in 23 different States, representing all classes of coal and secured under a great variety of climatic conditions, it will be seen that the results given in the following abstract of Mr. J. S. Burrows' summary of the sampling work form a most valuable contribution to this important subject.

The mine sampling was done by special inspectors who also supervised personally the shipment of the coal in car-load lots. On their arrival at St. Louis the cars were sampled in the following manner: the coal was passed through rolls set 1½ inches apart, from which it was discharged into the boot of a bucket elevator employed to hoist it to the storage bins. A small shovelful was taken from about every eighth or tenth bucket, the resulting sample amounting to 80 to 100 pounds. This was sent direct to the laboratory in an iron bucket, the pulverizing and quartering being done after it reached the laboratory. For the

mine sampling, two or more places were selected at widely separated points where the bed had an average development and from which most of the coal was being mined for shipment. The face was cleaned of dirt, burned powder and loose coal for a space of about five feet. The sample was then taken in a perpendicular cut from floor to roof, the cuttings being caught on a waterproof blanket. In taking each sample sufficient coal was cut to make up not less than five pounds per foot of height. When shale or other partings were to be included, great care was taken to cut them the full width and depth of the groove to preserve the proportion of coal and extraneous matter. Careful notes were taken of all variations and partings in the section of the bed and from these records an estimate of the value of the sample could be made. By repeated screening and breaking on a portable bucking board the sample was all reduced in size to pass a one-half inch screen. It was then thoroughly mixed by rolling in the blanket and quartered down to a convenient size for handling. A can was filled from the last quartering and hermetically sealed for mailing to the laboratory. The whole process was carried out in less than an hour. With such rapid sampling in the native atmosphere of the coal it was assumed that there would be little or no loss in moisture.

The results of the comparative analyses of the mine and car samples are shown in tabular form and from an examination of these data the coefficients by which mine samples may be corrected are obtained. With regard to moisture, it is found that a different correction has to be made for run-of-mine coal containing less than 5 per cent. of moisture from that which must be used for coals containing more than this percentage. Coals in the former class will, under normal conditions, gain some moisture on exposure to the air, and the moisture in the mine sample must be multiplied by 1.19 to obtain the probable amount in commercial run-of-mine coal. On the other hand, coals containing more than 5 per cent. of moisture will lose a portion of it on exposure and the coefficient in this case is 0.93. A prominent feature noted in comparing these two classes is that there seems to be a tendency on the part of the high-moisture coals and the low-moisture coals to approach a common limit very close to 5 per cent. Screened coal will tend to lose moisture under normal conditions, the coefficient being 0.97. A coefficient of 1.30 was found for slack but it is based on too meagre data to be reliable.

"It appears from all the evidence that moisture is an extremely irregular constituent of coal. For this reason, in taking mine samples great care should be exercised to select a dry place in the mine for cutting the sample and to prevent an excessive amount of moisture from getting into the coal in the form of water by the drip from the roof of the mine or by contact with the sample on the floor. It is of the utmost importance to crush the sample in the atmosphere of the mine, or where it has been impossible to procure a dry sample, to dry the coal before crushing until all signs of visible moisture have been removed. More important than anything else in this connection is the manner in which the sample is packed for the laboratory. The sample should be sealed in an air-tight glass jar, bottle, or can. . . . . .

"The differences in sulphur between mine samples and commercial coal will in most cases be slight, provided too much care is not used in excluding sulphur in partings and concretions from the sample. In the results of the Survey's investigations the sulphur in the run-of-mine samples very nearly balances, the correction coefficient being 1.07 for the coals showing less than 3 per cent. of sulphur in the mine samples and 1.06 for those containing more than 3 per cent. With the screened coal, the actual results show more sulphur than in the run-of-mine coal, but the differences between mine samples and car samples remain slight, the coefficient determined being 1.10. Of course, the sulphur content in coal of this class will vary slightly, depending on the grade of coal and the size of the screen through which it is passed, as well as the form in which the sulphur occurs. If the sulphur comes from the mine in large pieces of a uniform size, it will pass into the coal of corresponding size and the other grades will show less sulphur. On this account it will be difficult to predict the amount of sulphur that is likely to be found in any particular size.

"The results of the comparison of the ash in the mine samples with the ash in the

car samples show the greatest and most constant variation of all the impurities in the coals examined. The best comparisons are, of course, on the run-of-mine coal, and indicate that the ash will run higher in this grade of coal as marketed than in the mine sample. The coefficients determined, however, 1.62 for coal with less than 7 per cent. of ash and 1.28 for coal with ash over this percentage, are sufficiently accurate for correcting the mine samples, provided they are taken by the method already recommended.

"With regard to screened coal, the results are considered uncertain, and although the coefficient (1.37) determined for this class of coal may be applied to mine samples for screened coal in general as compared with run-of-mine coal, it is not recommended that it be used for a specific grade of coal, such as lump or nut.

"The coefficient determined for ash in slack coal, 1.86, is considered good for determining the amount of ash in this grade of coal when it contains a large amount of fine dust, but it will probably be found that the coefficient will not give accurate results for special grades of slack or for coals free from fine shale partings and with good roofs and floors."

THE CHINESE IRON INDUSTRY.

A DESCRIPTION OF THE HANYANG IRON AND STEEL WORKS AND FUTURE PROSPECTS OF THE CHINESE IRON INDUSTRY.

C. Blauel—Stahl und Eisen.

CONSIDERABLE interest attaches to a description of the Hanyang Iron and Steel Works, China, in *Stahl und Eisen* for January 1, in view of the fact that these works shipped to the United States during 1907 a considerable amount of basic pig and several lots of foundry iron. The article, which is abstracted below, is by C. Blauel, a former engineer of the works. Besides describing the Hanyang works, the only establishment of any importance in the country, Herr Blauel gives an interesting discussion of the past and probable future of the Chinese iron industry.

The Hanyang works lie at the confluence of the Han and Yangtse Rivers and close to the city of Hankow, the most important commercial centre on the great waterway formed by the latter stream. The distance to tidewater is about 730 miles. The works date from 1891, when they were founded by Governor Chang-Chi-Tung of the Province of Hupeh, the work being done under the direction of English engineers and most of the material coming from England. At that time the establishment consisted of two blast furnaces with a daily capacity each of 50 tons, 20 puddling furnaces arranged in groups of four with equipment of steam hammers and puddling rolls, two bessemer converters, each of 5 tons capacity, one 12-ton basic open-hearth furnace, two rolling mills, and additional equipment consisting of a foundry, smithy, machine shop, etc. Later the works became practically a branch of a large Belgian establishment and the operation was under the control of Belgian engineers and foremen. After a time, however, the return of about 80 Chinamen who were sent to Belgium for instruction drove out the foreign element and placed the direction of the works almost wholly in the hands of natives.

The blast-furnace plant has been in operation, with various interruptions, since 1894, but during the first year only one furnace was in blast. By the introduction of stoves and other improvements the capacity was later increased to 70 to 100 tons per day, according to the quality of the pig produced. The high cost of fuel prevented the puddling plant from ever becoming a commercial success and it remained in commission only a short time. Since the end of the nineties the chief output of the bessemer plant has consisted of rails for the 750-mile Hankow-Peking railway which was built between 1901 and 1905. Lately the converters and open-hearth plant have supplied steel to the plate mills. The total production of the rolling mills has never exceeded 15,000 to 25,000 tons per year and in most years has fallen considerably below these figures.

In 1896 the works were leased by Chang-Chi-Tung to a Chinese company and en-

tered on a period of mismanagement and commercial failure. In addition to the financial incapacity of the native managers, the establishment labored under technical difficulties, chief among which was the poor quality of the coke available. On one occasion the managers nearly put an end to the whole existence of the bessemer plant by entering into an agreement to supply for thirty years to the Japanese government 100,000 tons of the best magnetite ore annually. The remaining ores were too high in phosphorus for use in the converters. In 1904 the works passed under the control of a railway magnate Sheng-Kung-Pao, who decided to increase at once the open-hearth plant in order to make all the magnetic and hematite ores available.

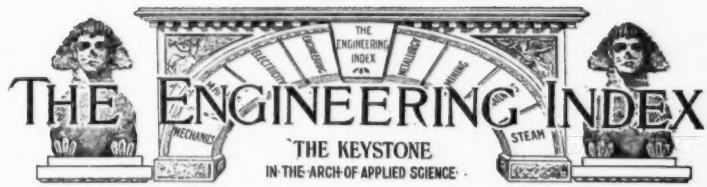
The ore deposits of the Tayeh district, the source of the Hanyang supply, consist chiefly of red hematite and magnetite containing on the average about 58 to 68 per cent. iron, 0.04 to 0.25 per cent. phosphorus, and 0.05 to 0.1 per cent. sulphur. Some brown hematite also is found, containing 6 to 9 per cent. manganese. The deposits are of enormous extent, occupying a mountain range about seven miles in length, and are estimated to contain more than 100,000,000 tons of available ore. Excellent limestone occurs alongside the iron ores and at a distance of about 20 miles there are large deposits of good coking coal. This district has natural advantages which should make it one of the most important centres of the Chinese iron industry.

These deposits are about 60 miles distant from Hankow and the ore is brought to the Hanyang works over a 15-mile railroad connecting with the Yangtse and thence by water. The Yangtse is navigable for the largest ocean steamers up to Hankow from April to October and transportation facilities for ores and finished product are therefore adequate. The main difficulty in the raw material supply is that the coke has to be brought from Ping-Hsiang, a distance of 60 miles by rail and 240 miles by water. The coke from these mines is of fair quality but the output so far is limited to little more than the amount required by the Hanyang works. The costs of raw materials at the furnaces are now about as follows: ore, 75 cents; limestone, 50 cents; coke, $6.25 to $7.50; and coal, $4.50 per ton.

The reorganization work under Sheng-Kung-Pao resulted in 1904 and 1906 in the installation of three 30-ton open-hearth furnaces, a gas-fired mixer of 150 tons capacity with gas producer equipment, three large reversing mills and accessories, and a direct-current electric plant of 800 kilowatts capacity. Early in 1907 a third blast furnace of 300 tons capacity and two additional open-hearth furnaces were ordered and in the near future a second mixer and a fourth blast furnace of the same capacity as the last will be installed. The old bessemer plant and puddling furnaces have been dismantled. The original plant worked continuously during the past year and the new steel plant was recently set in operation. The third blast furnace will be blown in before the end of this year.

The Hanyang works are in a better position than ever before for successful operation, but it is difficult to form an estimate as to what the future may bring forth. Encouraging features are the good equipment, better labor and satisfactory arrangements for raw material supply. During 1908 the output of the steel works and rolling mills will probably reach 40,000 to 50,000 tons and by 1910 it should reach 100,000 tons. The present manager, Mr. V. K. Lee, is a native of the highest type who has been thoroughly trained for his work in European steel works.

China has great possibilities as an iron producing country. The country has not been thoroughly explored, but immense deposits of high-grade ore are known to exist in many parts of the country. Mr. Blauel thinks that the total ore resources are not much less than those of the United States. Coking coal is not available in such large deposits but the supplies are extensive and would probably be found adequate. The most serious obstacle to the development of the iron industry is the new mining law which went into effect last November. By its provisions foreign capital cannot be employed directly in mining operations, but can be used only for the purchase of stock in Chinese companies. The incapacity of the Chinese in financial matters will prevent for a great many years at least the investment of any considerable amount of money in so hazardous a venture as the exploitation of mines under these circumstances.



The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Brooklyn.

The Manhattan Terminal Extension of Brooklyn Bridge. Brief illustrated description of recent changes to relieve the congestion on the elevated level of the bridge. 1200 w. Elec Ry Rev—Feb. 1, 1908. No. 90001.

New Terminal Station and Approaches of the Brooklyn Bridge. Illustrated description of the structure that will eventually take the place of the temporary building now used. 1600 w. Sci Am—Feb. 8, 1908. No. 90110.

Increasing the Capacity of Brooklyn Bridge. Illustrates and describes the most important changes recently made, with editorial on the report of the chief engineer of the Public Service Commission criticising the new system. 3200 w. R R Gaz—Feb. 21, 1908. No. 90449.

Cantilever.

Pin-Connected Highway Bridge over the Rhine between Hamburg and Ruhrort

We supply copies of these articles. See page 158.

(Pont-Route à Travées Articulées Etabli sur le Rhin entre Homburg et Ruhrort). Illustrated description of this bridge which has a cantilever span 620 feet long. 3000 w. Génie Civil—Jan. 4, 1908. No. 90332 D.

Concrete.

Progress on the Walnut Lane Bridge, Fairmount Park, Philadelphia. Construction work on the longest concrete arch in the world, 233 ft. clear span, is illustrated and described. 2500 w. Eng Rec—Feb. 15, 1908. No. 90198.

Drawbridges.

New Swing-Bridge Over the River Hull at Sculcoates, Hull. Plate, illustrations, and description of the bridge and method of erection. 1200 w. Engng—Jan. 31, 1908. Serial. 1st part. No. 90140 A.

Failures.

The Ponts-de-Cé Disaster (Die Katastrophe von Ponts-de-Cé). August Kroitzsch. Describes the failure of this steel bridge in France with an examination of causes. Ills. 2500 w. Oest Zeitschr f d Oeffent Baudienst—Jan. 25, 1908. No. 90365 D.

Reinforced Concrete.

Ferro-Concrete Highway Bridges. Illustrates and describes some recent designs in accordance with the Hennebique system. 1600 w. Surveyor—Feb. 7, 1908. No. 90241 A.

Cost of Constructing a Concrete Trestle and Three Concrete Girder Bridges with Abutments. Relates to a reinforced-concrete trestle and bridges with concrete abutments near Easton, Pa. 1300 w. Engng-Con—Feb. 5, 1908. No. 90090.

Steel.

Erection and Waterproofing of Plate Girder at Plainfield, N. J. Illustrated description of work carried out by the Central Railroad Company of New Jersey. 1200 w. Eng Rec—Feb. 1, 1908. No. 89963.

A Plate Girder Bridge Replacing a Bowstring Truss in Washington, D. C. W. J. Douglas. Illustrates both the old and new bridges, describing the work. 1500 w. Eng News—Feb. 13, 1908. No. 90165.

See also Brooklyn, Cantilever, Drawbridges, Failures, and Viaducts, under BRIDGES.

Timber.

See Trestle, under BRIDGES.

Trestles.

Formulas for Estimating the Quantities of Materials in Timber and Pile Trestles and Hints on Estimating Costs. 1000 w. Engng-Con—Feb. 12, 1908. No. 90175.

Viaducts.

The Cap Rouge Viaduct. Illustrated detailed description of a single-track steel structure for the Trans-Continental Railway, Canada, which is about 3345 ft. long, with a maximum height of nearly 173 ft. from low water to base of rail. 1500 w. Eng Rec—Feb. 22, 1908. No. 90467.

CONSTRUCTION.

Beams.

Stresses in Solid Beam Sections and the Strength of Chain Rings. Robert H. Smith. A study in the calculation of stresses in both rectangular and circular sections. 3000 w. Engr, Lond—Jan. 24, 1908. Serial. 1st part. No. 90017 A.

Buildings.

The General Equation of the Elasticity of Structures and Its Applications (L'Equation Générale de l'Elasticité des Constructions et ses Applications). Bertrand de Fontviolant. A mathematical discussion of stress determination in framed structures of various types. Ills. 20000 w. Mem Soc Ing Civ de France—Oct., 1907. No. 90303 G.

Concrete.

The Treatment of Concrete Surfaces. E. B. Green. Read before the Nat. Assn. of Cement-Users. Briefly discusses the possibilities of this material and its artistic application. 2000 w. Eng Rec—Feb. 22, 1908. No. 90466.

Methods and Costs of Concrete Construction with Separately Molded Members. W. H. Mason. From a paper before the Nat. Assn. of Cement Users. Describes a cement storage building constructed on this system. 2500 w. Munic Engng—Feb., 1908. No. 90180 C.

See also same title, under MATERIALS OF CONSTRUCTION.

Estimates.

Approximate Estimates. Alexander Potter. Read before the Ohio Engng. Soc. States the purpose of such estimates and their value in contracts. 2200 w. Eng Rec—Feb. 22, 1908. No. 90474.

Excavation.

The Use of a Water Jet to Increase the Speed of Rock Drilling and a Formula Estimating the Amount of Water Necessary. Gives a rule that may be easily applied, and a solution of this problem. 1300 w. Engng-Con—Feb. 5, 1908. No. 90091.

Failures.

See Roofs, under CONSTRUCTION.

Foundations.

Sinking Well and Cylinder Foundations. Edward W. Stoney. Gives work done by divers in sinking bridge, well, and cylinder foundations in India. 1200 w. Engng—Jan. 31, 1908. No. 90135 A.

A Steel Pile Foundation in a Quicksand Pocket. Brief description of method of solving a serious problem in erecting a 16-story building in New York. Ills. 1000 w. Eng Rec—Feb. 22, 1908. No. 90465.

Supporting a Foundation Wall on a Reinforced-Concrete Girder. Brief illustrated description of method used in connection with excavations for the Bridge Loop for the subway system, New York. 500 w. Eng Rec—Feb. 15, 1908. No. 90199.

Masonry.

How to Preserve Stonework. W. M. Brown. Brief review of methods for cleaning and preserving stonework in cities. 1500 w. Can Archt—Feb., 1908. No. 90561 C.

Piling.

Preservation of Piling Against Marine Wood Borers. C. Stowell Smith. A study of the character and extent of the damage done and of the present methods of protection. Ills. 4000 w. U S Dept of Agri—Circ 128. No. 90539 N.

See also Foundations, under CONSTRUCTION.

Reclamation.

The Improvement of the Upper Mystic River and Alewife Brook by Means of Tide Gates and Large Drainage Channels. J. R. Rablin. An account of improvements in the vicinity of Boston. 2000 w. Harvard Engng Jour—Jan., 1908. No. 90189 D.

Swamp and Overflowed Land Drainage in the Mississippi Basin. F. W. Hanna. Discusses the detrimental changes in the flow of rivers, due to the extensive changes in forest conditions, and the necessity for intelligent control in order to accomplish the greatest good. 2500 w. Eng News—Feb. 13, 1908. No. 90166.

Reinforced Concrete.

Systems of Reinforced-Concrete Construction. Emile G. Perrot. From a paper before the Nat. Assn. of Cement Users. Calls attention to important points in the construction. 1400 w. Munic Engng—Feb., 1908. No. 90181 C.

Spiral Anchorage for Concrete Reinforcement. Daniel B. Luten. Explains this form of anchorage, its principle, and the advantage of its use in certain cases. 1200 w. Eng News—Feb. 27, 1908. No. 90522.

The Necessity of Continuity in the Steel Reinforcement of Concrete Structures. E. P. Goodrich. Read before the Nat. Cement Users' Assn. Mainly a discussion of the prevention of cracks, but considering also causes of stresses in monolithic structures. 3500 w. Eng Rec—Feb. 8, 1908. No. 90095.

Reinforced Concrete for Railway Structures. Charles Augustus Harrison. Paper and discussion before the Railway Section of the Engng. Conference, 1907. 3400 w. Bul Int Ry Cong—Jan., 1908. NO. 90283 E.

Self-Sustaining Reinforcement of Structural Shapes in a Cement Stock House. Illustrates and describes an example of concrete reinforcement so designed as to make a self-sustaining steel framework before the concrete is placed. 3000 w. Eng News—Feb. 6, 1908. No. 90087.

A Reinforced Concrete Hotel. Day Allen Willey. Illustrated description of the Traymore, at Atlantic City, N. J. 1200 w. Sci Am—Feb. 15, 1908. No. 90194.

A Reinforced-Concrete Building with Concrete Domes: Cincinnati Zoological Garden. Illustrations with brief description of the Herbivora Building. 900 w. Eng News—Feb. 20, 1908. No. 90404.

Market Hall in Breslau between Garten and Friedrich Streets (Markthallenbau in Breslau zwischen Garten- und Friedrichstrasse). Rudolf Heim. Illustrated description of this large arched structure. 1500 w. Serial. 1st part. Beton u Eisen—Jan. 27, 1908. No. 90377 D.

See also Roofs, under CONSTRUCTION; Concrete, under MATERIALS OF CONSTRUCTION; Septic Tanks, under MUNICIPAL; Dams, and Pipe Laying, under WATER SUPPLY; Construction, under ELECTRICAL ENGINEERING, GENERATING STATIONS; Dry Docks, under MARINE AND NAVAL ENGINEERING; and Roundhouses, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Retaining Walls.

See Flood Protection, under WATERWAYS AND HARBORS.

Roofs.

A Study of Roof Trusses. N. Clifford Ricker. Investigations made to determine a formula for the weight of roof trusses more accurate than those used. 3000 w. Bul No. 16, Univ of Illinois—Aug. 19, 1907. No. 90535 N.

The Failure of the Concrete Roof of the Lawrence, Mass., Filter. Abstract of a report by Sanford E. Thompson on the causes of this accident. 1600 w. Eng News—Feb. 27, 1908. No. 90525.

The New Roof of Charing Cross Station. Brief account of the method of removing the old roof, and illustrated detailed description of the new roof of the ridge-and-furrow type. 2000 w. Engng—Feb. 7, 1908. Serial. 1st part. No. 90255 A.

Steel Buildings.

Structural Steel Details of the Brooklyn Academy of Music. Illustrates and describes building details of a steel cage structure. 3000 w. Eng Rec—Feb. 22, 1908. No. 90469.

See also Roofs, and Warehouses, under CONSTRUCTION.

Tunnels.

See Subways, under STREET AND ELECTRIC RAILWAYS.

We supply copies of these articles. See page 158.

Warehouses.

The New Steel Warehouse Plant of the Carnegie Steel Co. at Waverly, N. J. Illustrated detailed description of the plant and its equipment. 3500 w. Ir Trd Rev—Feb. 20, 1908. No. 90419.

The Carnegie Steel Company's Newark Warehouses. Illustrates and describes the largest plant in the world for the storage of structural and merchant steel. 1500 w. Ir Age—Feb. 20, 1908. No. 90297.

Water Proofing.

See Steel, under BRIDGES; and Concrete, under MATERIALS OF CONSTRUCTION.

MATERIALS OF CONSTRUCTION.

Concrete.

Investigations of Impermeable Concrete by the Laboratory of the Board of Water Supply, New York City. James L. Davis. Read before the Nat. Cement Users' Assn. 1200 w. Engng-Con—Feb. 26, 1908. No. 90563.

Proportions of Concrete and Methods of Mixing. L. C. Wason. Read before the Nat. Assn. of Cement Users, at Buffalo. On the proportions and strength of concrete, equipment, methods, and cost. 3000 w. Eng Rec—Feb. 15, 1908. No. 90207.

Tests to Determine the Effect of Mica on the Strength of Concrete. W. N. Willis. Gives curves showing the results of tests made to determine the effect of mica on the tensile strength of concrete. 500 w. Eng News—Feb. 6, 1908. No. 90086.

Tests on Plain and Reinforced Concrete. Morton Owen Withey. A report of tests of bond; effect of compression reinforcement in beams; overhanging beams; diagonal tension failures and methods of prevention; and tee beams. Ills. 7500 w. Bul Univ of Wis, No. 175—Nov., 1907. No. 90413 C.

Concrete Brick.

The Manufacture of Concrete Bricks from Blast Furnace and Other Slag. Josiah Butler. Read before the Staffordshire Ir. & St. Inst. Illustrated description of a method of utilizing this waste material profitably. 6000 w. Ir & Coal Trds Rev—Jan. 24, 1908. No. 90020 A.

Paints.

See Protective Materials, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Reinforced Concrete.

See Concrete, under MATERIALS OF CONSTRUCTION.

Timber Preservation.

Treating Wood that is Refractory to Treatment and Also Subject to Decay. David Allerton. Abstract of a paper read before the Wood Preservers' Assn. Deals with the creosoting of the Douglas fir. 800 w. Eng News—Feb. 20, 1908. No. 90405.

The Seasoning and Preservative Treatment of Arborvitae Poles. C. Stowell Smith. An illustrated report of experimental investigations on the preserving of this wood. 6500 w. U S Dept of Agri—Circ 136. No. 90540 N.

The Preservative Treatment of Fence Posts. Howard. F. Weiss. Shows how fence posts may be treated and with what results. 3000 w. U S Dept of Agri—Circ 117. No. 90537 N.

United States Wood Preservers' Association. An account of the recent meeting, giving the secretary's report which shows the work already done; with papers on methods of treatment. 5000 w. Ry Age—Jan. 31, 1908. No. 89977.

See also Piling, under CONSTRUCTION.

MEASUREMENT.

Hydrographic Surveying.

Magnetic Survey on the Pacific Ocean. Herbert T. Wade. An illustrated account of the work being executed by the Carnegie Institution of Washington. 1800 w. Sci Am—Feb. 15, 1908. No. 90195.

Stream Flow.

The Gauging of Irrigation Waters (Aforo de las Aguas de Riego). Julian Romero. A mathematical discussion of methods, the first part dealing with the flow over weirs. Ills. 6000 w. Serial. 1st part. Ingenieria—Dec. 30, 1907. No. 90341 D.

Surveying.

Bench Level Operations on the Catskill Aqueduct Line. M. E. Zipser. Gives the principal features of the bench level work from the Ashokan Reservoir to Croton watershed. Ills. 2500 w. Eng News—Feb. 20, 1908. No. 90408.

See also Hydrographic Surveying, under MEASUREMENT; and Surveying, under MINING AND METALLURGY, MINING.

MUNICIPAL.

City Improvement.

Civic Centers and the Grouping of Public Buildings, with a Suggestion for Boston. Stephen Child. Reviews recent developments aiming to beautify cities, with a suggestive study of the possibilities at Boston. Ills. General discussion. 10000 w. Jour Assn of Engng Socs—Jan., 1908. No. 90429 C.

Drainage.

The Run-Off from Sewered Areas. Preliminary report of the committee appointed by the Boston Society of Civil Engineers to collect data bearing on this subject. 1600 w. Eng News—Feb. 27, 1908. No. 90519.

We supply copies of these articles. See page 158.

Garbage Disposal.

See Street Cleaning, under MUNICIPAL; and Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Pavements.

Hysteria in Regard to Pavements. Clifford Richardson. A discussion of the paving problem in the United States. 3000 w. Eng Rec—Feb. 15, 1908. No. 90204.

Compressed Rock Asphalts Used on London Roadways. S. A. Ionides. The use of black asphalts and mastic, the preparation, and method of laying and repairing. Ills. 1000 w. Min Sci—Feb. 6, 1908. No. 90113.

Roads.

The Cost of Grading a Wagon Road in Winter. Itemized report of costs. 1200 w. Engng-Con—Feb. 26, 1908. No. 90564.

Experiments with Tar and Oil on the Highways of Rhode Island. Arthur Horace Blanchard. Read before the Am. Assn. for the Adv. of Science. Gives a classification of the highways experimented upon, descriptions and cost data. 3500 w. Eng Rec—Feb. 8, 1908. No. 90100.

Road Resistance. C. E. Morrison. A study of the factors affecting the tractive force per unit load; viz, axle friction, rolling resistances, and grade resistances. 3800 w. Sch of Mines Qr—Jan, 1908. No. 90428 D.

The Commercial Use of Highways. H. Howard Humphreys. From a paper read before the Soc. of Road Traction Engrs., London. Discusses what has already been done in England, the repair of highways and bridges, traffic, etc. General discussion. 9500 w. Surveyor—Feb. 14, 1908. No. 90483 A.

Septic Tanks.

A Septic Tank at Ithaca, New York. Describes the construction of a reinforced concrete septic tank and new outfall. Ills. 1500 w. Eng Rec—Feb. 1, 1908. No. 89964.

See also Sewage Disposal, under MUNICIPAL.

Sewage Disposal.

Investigations on the Purification of Boston Sewage in Septic Tanks and Trickling Filters (1905-1907). C.-E. A. Winslow and Earle B. Phelps. A full account of investigations at the Sewage Experiment Station of the Massachusetts Institute of Technology, with description of the plant and methods. 18000 w. Tech Qr—Dec., 1907. No. 90542 E.

Purification of Boston Sewage: Experimental Results and Practical Possibilities. C.-E. A. Winslow and Earle B. Phelps. A report of investigations at the Sewage Experiment Station of the Massachusetts Institute of Technology, dealing with the coming problem rather than the present. Also discussion. 9500 w. Jour Assn of Engng Socs—Jan., 1908. No. 90430 C.

Discussion on Modern Methods of Sewage Disposal, with Special Reference to the Elimination of Suspended Matters. Also description of sewage disposal works at Leeds, Eng. 7000 w. Jour Roy San Inst—Feb., 1908. No. 90176 B.

Sewerage at Ithaca. Describes the system in use, illustrating the septic tanks. 1500 w. Munic Jour & Engr—Feb. 5, 1908. No. 90026.

Sewerage and Sewage Disposal at Fairmont, Minn. A. Marston. Describes the conditions to be met, and gives an illustrated description of the system as constructed. 1200 w. Eng Rec—Feb. 1, 1908. No. 89961.

Sewage Disposal Plant at the Montefiore Sanitarium. Illustrated description of the plant at Bedford Station, N. Y., designed to handle 30000 gal. per day. 1500 w. Eng Rec—Feb. 15, 1908. No. 90205.

The Use and Removal of the Products of Sewage Purification Plants (Verwertung und Beseitigung des Klärschlammes aus Reinigungsanlagen städtischer Abwässer). Herrn Metzger and Haack. Two papers. 7700 w. Gesundheits-Ing—Jan. 25, 1908. No. 90367 D.

Biological Purification of Sewage (Epuration Biologique des Eaux d'Egout). Paul Vincey. Discusses septic tanks, artificial beds, etc., giving a number of illustrations of methods and results of the best European and American practice. Ills. 16000 w. Bul Soc d'Encour—Dec., 1907. No. 90318 G.

The Utilization of Peat for the Purification of Sewage (Sur l'Utilisation de la Tourbe pour l'Epuration des Eaux d'Egout). MM. A. Müntz and E. Lainé. The results of investigations on the value of peat as an agent in the nitrification of sewage. 1800 w. Comptes Rendus—Jan. 13, 1908. No. 90331 D.

See also Septic Tanks and Sewers, under MUNICIPAL; Canals, under WATERWAYS AND HARBORS; and Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Sewers.

A Cast-Iron Pressure Sewer in a Railroad Yard. Describes work at Tompkinsville, Staten Island, N. Y., in the yard of the B. & O. R. R. Ills. 1000 w. Eng Rec—Feb. 15, 1908. No. 90201.

A Suspended Sewer. W. R. Worthington. Illustrates and describes the methods used in a ravine district of Toronto. 1200 w. Can Engr—Feb. 7, 1908. No. 90146.

We supply copies of these articles. See page 158.

New Trunk Sewers and Sewage Disposal Works for the City of Regina, Sask. Extracts from the report of Lea and Smith, consulting engineers to the City Council. Describes the present and the recommended works. 7000 w. Can Engr—Feb. 7, 1908. No. 90147.

Progress on the Baltimore Sewerage Works. Notes from the report of Calvin W. Hendrick. Ills. 1500 w. Eng Rec—Feb. 8, 1908. No. 90101.

See also Drainage, under MUNICIPAL.

Street Cleaning.

Street Cleaning and Waste Disposal in New York. A review of conditions, and improvements suggested by a commission appointed by the Mayor to plan a more effective system. 3300 w. Eng Rec—Feb. 22, 1908. No. 90468.

WATER SUPPLY.

Appalachian Watersheds.

Report of the Secretary of Agriculture on the Southern Appalachian and White Mountain Watersheds. James Wilson. On the commercial importance, area, condition, advisability of their purchase for national forests, and probable cost. Maps. 15500 w. Gov Print Office—Doc. No. 91. No. 90536 N.

Aqueducts.

Preliminary Work on the Los Angeles Aqueduct. Illustrates and describes work preparatory to the carrying out of this extensive project, explaining some of the difficulties. 5000 w. Eng Rec—Feb. 8, 1908. No. 90094.

Ashokan.

The Estimated Cost of the Main Ashokan Dams. A statement of the methods followed by the engineers of the Board of Water Supply, with editorial comment. 8500 w. Eng Rec—Feb. 15, 1908. No. 90202.

The Estimated Cost of the Ashokan Reservoir and Data of Actual Cost of Similar Earth Embankments, Together with a Discussion of the Testimony Submitted in the Investigation of the Ashokan Dam Award. 4500 w. Engng-Con—Feb. 12, 1908. Serial. 1st part. No. 90174.

Quality of Bluestone in the Vicinity of the Ashokan Dam. Charles P. Berkey. A summary of the observations, arguments and conclusions from a study of the materials in the vicinity that could be safely utilized in the construction of this great dam. Ills. 3500 w. Sch of Mines Qr—Jan., 1908. No. 90427 D.

Croton Watershed.

How Large a Water Supply Can Be Drawn from Croton Drainage Area, New York City. Alfred D. Flinn. An interesting and valuable article showing the cost of storing the surplus waters in the dryest and also the wettest periods, and giving much information relating to water supply. Also editorial. 4500 w. Eng News—Feb. 6, 1908. No. 90088.

Dams.

Reinforced Concrete Diaphragms for Earth Dams. B. M. Hall. Describes the Avalon dam of earth and loose rock, with a reinforced-concrete diaphragm. 700 w. Eng News—Feb. 6, 1908. No. 90085.

The Construction of the Laguna Dam, Colorado River, Arizona. States the conditions and requirements of the Yuma valley irrigation project, and the method of building a rock-filled dam 4800 ft. long and 226 ft. wide, with three concrete core walls, practically under water. Ills. 2500 w. Eng News—Feb. 27, 1908. No. 90517.

The High Needle Dams on the Big Sandy River, U. S. A. B. F. Thomas. Illustrates and describes dams of the movable type, that are lowered on to the bed of the river in times of freshet. Plates. 2200 w. Engng—Jan. 17, 1908. No. 90042 A.

The Gileppe Dam (Barrage de la Gileppe). M. Bodson, D. Detienne and F. Leclercq. Illustrated description of the design of this large masonry dam. 3500 w. All Indus—Jan., 1908. No. 90330 D.

The Construction of Earth Dams by Hydraulic Filling (La Construction des Barrages en Terre par Remblayage Hydraulique). A. Dumas. Illustrates and describes work on several dams in America built by this method. 5000 w. Génie Civil—Jan. 11, 1908. No. 90333 D.

See also Ashokan, and Sluice Gates, under WATER SUPPLY.

Evaporation.

Studies on the Rate of Evaporation at Reno, Nevada, and in the Salton Sink. Frank H. Biglow. Briefly describes this region and the formation of the Salton Sea, and gives results of studies made of the rate of evaporation. Ills. 4000 w. Nat Geog Mag—Jan., 1908. No. 90412 C.

Filtration.

The Development of the Mechanical Filter Plant. Phillip Burgess. Read before the Ohio Engng Soc. Indicates the development from the early wooden tub to the modern concrete tank. 5000 w. Eng Rec—Feb. 22, 1908. No. 90475.

The Didelon Regulator for Filter-Beds. Illustrated description of an apparatus in use in Europe. 700 w. Engng—Jan. 17, 1908. No. 90048 A.

Irrigation.

Irrigation Plants in Egypt (Aegyptische Bewässeranlagen). E. F. Huber. Illustrates and describes several large pumping plants installed by Sulzer Brothers. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 11, 1907. No. 90381 D.

We supply copies of these articles. See page 158.

New York City.
See Croton Watershed, under WATER SUPPLY.

Pipe Corrosion.
Electrolysis. Albert F. Ganz. Read before the Am. Gas Inst. A report of tests and investigations, with general discussion. 6000 w. Pro Age—Feb. 1, 1908. No. 89974.

Investigations on the Rusting of Iron (Untersuchungen über das Rosten von Eisen). A. Schleicher and G. Schultz. Results of investigations to determine whether cast iron is more susceptible to electrolytic corrosion than wrought iron. Ills. 2000 w. Stahl u Eisen—Jan. 8, 1908. No. 90345 D.

Pipe Laying.
A Traveling Mold for Making Reinforced-Concrete Pipe. F. Teichman. Illustrated description of the design and working of these forms. 2500 w. Eng. News—Feb. 20, 1908. No. 90407.

Pipe Lines.
See Water Works, under WATER SUPPLY.

Pueblo, Col.
An Unusual Water Supply for Industrial Purposes. The design, construction and operation of the water supply system of the Minnequa steel works at Pueblo, Colo., is illustrated and described. 5000 w. Eng Rec—Feb. 22, 1908. No. 90464.

Purification.
Water Purification in Ohio. Notes from a preliminary report recently made by R. Winthrop Pratt, of the State Board of Health. 3800 w. Eng Rec—Feb. 22, 1908. No. 90470.

Reservoirs.
See Pueblo, Col., and Water Works, under WATER SUPPLY.

Sluice Gates.
Electrically Operated Sluice Gates and Drop-Timber Regulator Gates for the Laguna Dam. F. W. Hanna. Illustrates and describes these large sluice gates and their operating machinery. 2000 w. Eng. News—Feb. 27, 1908. No. 90518.

Stream Flow.
A Logarithmic Diagram for the Flow of Water in Open Channels. George T. Prince. Gives a diagram based upon the Chezy formula, with explanation. 300 w. Eng News—Feb. 6, 1908. No. 90083.

Stream Gauging.
See Stream Flow, under MEASUREMENT.

Typhoid Fever
See Washington, D. C., under WATER SUPPLY.

Washington, D. C.
Water Supply and Typhoid Fever at Washington, D. C. Information presented at a meeting of the Medical Society of the District of Columbia, with editorial. 5000 w. Eng News—Feb. 27, 1908. No. 90521.

Water Works.
The Construction of Small Water Works. The Kilbirnie works, in Ayrshire, Scotland, are illustrated and described as an example of a case where gravitation supply is available. 2500 w. Engng—Jan. 31, 1908. No. 90137 A.

The Water-Works of Portland, Ore. W. P. Hardesty. History and illustrated description of the works, pipe lines, reservoir system, etc. 5500 w. Eng News—Feb. 6, 1908. No. 90082.

WATERWAYS AND HARBORS.

Barge Canal.
See Locks, under WATERWAYS AND HARBORS.

Breakwaters
History of the Reaction Breakwater at Aransas Pass, Texas. Lewis M. Haupt. Maps. 10000 w. Jour Fr Inst—Feb., 1908. No. 90431 D.

Canals.
System of Natural Transportation by Water. Brief illustrated description of a scheme, devised by an Italian civil engineer, in which the propulsion of the boat is effected by hydraulic differences of level. 1800 w. Prac Engr—Feb. 14, 1908. No. 90484 A.

The Future of the Chicago Drainage Canal. Editorial review of the various phases of sewage disposal, water supply, harbor facilities and other subjects affecting the future usefulness of this costly waterway. 4500 w. Eng News—Feb. 13, 1908. No. 90169.

See also German Canals, and Panama Canal, under WATERWAYS AND HARBORS.

Dredging.
See Dredges, under MARINE AND NAVAL ENGINEERING.

Flood Protection.
Flood Protection Along Cherry Creek in Denver, Colorado. Describes the reinforced-concrete retaining walls which form the sides of the new channel. Ills. 1400 w. Eng Rec—Feb. 15, 1908. No. 90200.

See also Dams, under WATER SUPPLY; and Levees, under WATERWAYS AND HARBORS.

Floods.
The Flood of March, 1907, in the Sacramento and San Joaquin River Basins, California. W. B. Clapp, and W. F. Martin, Jun. A study of the topography and drainage of the region, the climate, flood conditions and causes, precipitation, flood flow, effects, etc. Map. 14500 w. Pro Am Soc of Civ Engrs—Feb., 1908. No. 90554 E.

We supply copies of these articles. See page 158.

German Canals

The Development of Inland Navigation in Germany from 1875 to 1905 (Die Entwicklung der deutschen Binnenschiffahrt in den Jahren 1875-1905). Herr Ragoczy. Gives details of the waterways and statistics of the freight traffic. 4500 w. Glückauf—Jan. 4, 1908. No. 90353 D.

Harbors.

See Canals, under WATERWAYS AND HARBORS.

Italian Waterways.

The Technical Problems of Inland Navigation (Il Problema Tecnico sulla Navigazione Interna). Edoardo Sassi. Discusses the problems in the attempt to improve inland navigation in Italy. 5500 w. Ann Soc Ing Arch Italiani—Jan., 1908. No. 90338 F.

Levees.

Closing a 700-Foot Break in the Mississippi Levees. Paul J. Brand. An illustrated account of the methods and new features of this important work. 2000 w. Sci Am—Feb. 22, 1908. No. 90478.

Lighthouses.

Sangandeb Lighthouse, Red Sea. Illustrated description of the construction of this lighthouse for the new harbor of Port Sudan, the sea terminal of the new railway connecting the Nile with the Red Sea. 1500 w. Engr, Lond—Jan. 24, 1908. No. 90018 A.

Locks.

Construction of Lock 3, Erie Barge Canal. Oscar Hasbrouck. Illustrates and describes the lock at Waterford, N. Y. 1000 w. Eng Rec—Feb. 8, 1908. No. 90097.

Marine Growths.

The Water Hyacinth. G. C. Scherer. An account of what has been done to rid the streams in the south of this troublesome growth which obstructs navigation and causes other troubles. 1200 w. Eng News—Feb. 20, 1908. No. 90409.

North Sea.

The Strategical Position in the North Sea as Strengthened by the "Forth and Clyde Battleship Canal" and the "Dover and Sangatte Tube Railway." Sir Charles Campbell, with general discussion. 14500 w. Jour Roy U Serv Inst—Jan., 1908. No. 90178 E.

Panama Canal.

The Panama Canal: A Brief Statement of Work, Equipment and Finances. Condensed statement of report of the Isthmian Canal Commission. 1000 w. Eng News—Feb. 13, 1908. No. 90167.

See also Panama Railway, under RAILWAY ENGINEERING, MISCELLANY.

Piers.

Sheathing Piers on Lake Erie with Divers. Wilson T. Howe. Describes work at Huron, O. 1200 w. Eng News—Feb. 20, 1908. No. 90406.

Transfer Bridges.

See same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Water Powers.

The Great Water Powers of the Alps (Etude des Grandes Forces Hydrauliques de la Region des Alpes). Paul Lévy-Salvador. Their importance and extent, and the work and methods of a commission recently appointed to study them. Ills. 3000 w. Serial. 1st part. Génie Civil—Jan. 18, 1908. No. 90335 D.

MISCELLANY.

Caisson Disease.

The Hygiene of Work in Compressed Air. J. S. Haldane. A short account of the causes and prevention of the troubles and dangers to health associated with work in compressed air. 9000 w. Jour Soc of Arts—Jan. 24, 1908. No. 90002 A.

Review of 1907.

The Progress of Electrical Science During 1907. E. E. Fournier d'Albe. A review of advances and theories discussed in the many papers submitted. 3300 w. Elect'n, Lond—Feb. 14, 1908. Serial. 1st part. No. 90490 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Fire Alarm.

An English Automatic Fire-Alarm System. Illustrated description of the May-Oatway system, in use in England and Scotland. 1200 w. Eng News—Feb. 6, 1908. No. 90089.

Radio-Telegraphy.

Recent Patents in Wireless Telegraphy. W. H. Eccles. Discusses the noteworthy patents of the past year. 3500 w. Elect'n, Lond—Jan. 24, 1908. Serial. 1st part. No. 90011 A.

Telegraphy.

Duplex and Quadruplex Operation with Ordinary Telegraph Instruments (Duplex et Quadruplex Réalisables au Moyen des Appareils Télégraphiques Ordinaires). M. Henry. Illustrated description of method. 2500 w. Soc Belge d'Elect'n—Jan., 1908. No. 90308 E.

We supply copies of these articles. See page 158.

Telephony.

Telephone Progress During the Past Year. B. S. Cohen. Gives statistics for the United Kingdom. 1200 w. Elect'n, Lond—Feb. 7, 1908. No. 90252 A.

DISTRIBUTION.

Switches.

See Electric Power, under MINING AND METALLURGY, COAL AND COKE.

Wiring.

The Kuhlo System of Protected Wiring for Interiors (Conducteurs Cuirassés pour Installations Intérieures Système Ernst Kuhlo). J. A. Montpelier. Illustrated detailed description of new devices for wire suspension, insulators, etc. 2400 w. Electricien—Jan. 4, 1908. No. 90323 D.

DYNAMOS AND MOTORS.

A. C. Dynamos.

A High-Frequency Alternator. Louis Cohen. Suggests a building up process of attaining high frequencies from a number of alternators on a common shaft. 1200 w. Elec Wld—Feb. 15, 1908. No. 90161.

D. C. Dynamos.

The Armature in Direct-Current Machines (Ueber die Ausnützung der Anker von Gleichstrommaschinen). Thomas Rosskopt. A mathematical discussion of its design. Ills. 4400 w. Elektrotech u Maschinenbau—Jan. 5, 1908. No. 90368 D.

D. C. Motors.

See Interpoles, under DYNAMOS AND MOTORS.

Efficiency.

Standard Performances of Electrical Machinery. Dr. Rudolph Goldschmidt. Puts forward suggested figures for standard performances, efficiencies, etc., which may serve as private standards. Particulars are mostly given in form of curves, with comments. 5000 w. Inst of Elec Engrs—Jan., 1908. No. 90013 N.

Heating.

The Heat Conductivity of Iron Stampings. Thomas Morgan Barlow. Describes investigations made on the rate of flow of heat in electrical machines built up of iron stampings. Ills. 3500 w. Inst of Elec Engrs—Jan., 1908. No. 90010 N.

Induction Motors.

See Motor Testing, under MEASUREMENT.

Interpoles.

Variable-Speed Commutating-Pole Motors. A. G. Ellis. Gives calculation tending to show that the permissible maximum e. m. f. between segments is soon reached in these motors. Ills. 2500 w. Elec Wld—Feb. 8, 1908. No. 90065.

Railway Motors.

Choice Railway Motors as Influenced by Gear Ratio. P. Gesing. Abstracted from *Elek. Kraft. und Bahnen.* Explains a graphical method of arriving at the most favorable conditions as regards watt-seconds per ton-meter. Also short note by W. Bethge, on the "Effect of Gear Ratio on Energy Consumption." 1000 w. Elect'n, Lond—Jan. 31, 1908. No. 90131 A.

Slot Openings.

The Reduction of Slot Openings by Means of Iron Bridge-Pieces. Gives an account of experiments made by Dr. R. Goldschmidt. 800 w. Elec Rev, Lond—Feb. 7, 1908. No. 90249 A.

Synchronous Motors.

The Synchronous Motor. Prof. C. A Adams. The first of a series of articles aiming to give a thorough understanding of the physical phenomena involved in synchronous motor operation. 5000 w. Harvard Engng Jour—Jan., 1908. Serial. 1st part. No. 90186 D

ELECTRO-CHEMISTRY.

Cells.

Recent Developments in Electrolytic Cells. Henry Stanley Renaud. An illustrated description of the Billitzer cell, with brief notes on other well known types. 1000 w. Eng & Min Jour—Feb. 22, 1908. No. 90458.

Corrosion.

The Corrosion of Steel. Allerton S. Cushman. An explanation of the electrochemical or electrolytic theory, now generally accepted. 3500 w. Jour Fr Inst—Feb., 1908. No. 90432 D.

See also Pipe Corrosion, under CIVIL ENGINEERING, WATER SUPPLY.

Electro-Metallurgy.

Process and Apparatus for the Production of Carbon Bi-Sulphide in the Electric Furnace. Edward R. Taylor. Illustrated detailed description. 5000 w. Jour Fr Inst—Feb., 1908. No. 90434 D.

The Manufacture of Calcium Cyanamide—The Beginnings of a New Electrical Industry. John B. C. Kershaw. Facts relative to the development of the Frank and Caro process for the fixation of nitrogen. 4000 w. Elect'n, Lond—Jan. 24, 1908. No. 90012 A.

See also same title, under MINING AND METALLURGY, IRON AND STEEL.

Indigo.

The Reduction of Indigo by Electrolysis (La Réduction de l'Indigo par Voie Electrolytique). M. Chaumat. A description of the author's researches on the use of electrolysis for breaking down organic substances. 6000 w. Bul Soc Int d'Elecns—Jan., 1908. No. 90310 F.

Nitrogen.

The Fixation of Atmospheric Nitrogen (La Fixation de l'Azote Atmosphérique au Moyen de l'Electricité). M. Blondin. The importance of the industry, methods,

etc. 5000 w. Bul Soc Int d'Elecns—Jan., 1908. No. 90309 F.

Ozone.

The Actual State of the Ozone Industry (L'Etat Actuel de l'Industrie de l'Ozone). H. de la Coux. Its production by electric discharges and its industrial uses. 6800 w. Rev Gen des Sciences—Jan. 30, 1908. No. 90322 D.

ELECTRO-PHYSICS.

Solenoids.

The Self-Inductance of a Coil of Any Length Wound with Any Number of Layers of Wire. Edward B. Rosa. Shows how one may obtain accurately the self-inductance of such coils. 2200 w. Bul Bureau of Stand—Jan., 1908. Vol. 4, No. 3. No. 90528 N.

Self-Inductance of a Solenoid of Any Number of Layers. Louis Cohen. Develops a formula which will give results accurate to within one-half of 1 per cent. even for a short solenoid; the accuracy increasing with the length. 1200 w. Bul Bureau of Stand—Jan., 1908. Vol. 4, No. 3. No. 90529 N.

Thermo-Electric Properties.

Thermo-Electric Properties of Common Metals and Their Alloys. A. G. Warren and F. Murphy. A report of experimental investigations. 1000 w. Elect'n, Lond—Jan. 31, 1908. No. 90132 A.

GENERATING STATIONS.

Central Stations.

Electrical Generating Station at Brussels. Illustrated detailed description. 2500 w. Engr, Lond—Jan. 31, 1908. No. 90144 A.

Greenock Electricity Department. Brief illustrated description of the opening of a new refuse destructor station. 1700 w. Elec Engr, Lond—Feb. 14, 1908. No. 90486 A.

Power Plant of the Borough of Pennsburg, Pa. Illustrates and describes an electric plant for a borough of about 1,000 population, generating current with oil engines. 1500 w. Engr, U S A—Feb. 15, 1908. No. 90271 C.

Plant of the Urbana (Illinois) Light, Heat & Power Co. Illustrated description of the plant, which runs in close connection with the Champaign, Peoria, and Danville plants. 2500 w. Engr, U S A—Feb. 1, 1908. No. 89993 C.

See also Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Construction.

The Westport Reinforced Concrete Power House. Illustrated description of a power house on the outskirts of Baltimore, Md. 3000 w. Eng Rec—Feb. 1, 1908. No. 89958.

Hydro-Electric.

The Sanitary District of Chicago's Hydroelectric Development on the Chicago Drainage Canal. Illustrated detailed description. 2500 w. Elec Rev, N Y—Feb. 8, 1908. No. 90093.

The Largest Electric Supply System in Vermont. Illustrated description of the system of the Consolidated Lighting Co. of Montpelier, which supplies electricity from Bolton Falls to Williamstown, a distance of 26 miles. 3000 w. Elec Rev, N Y—Feb. 1, 1908. No. 89965.

Power Transmission from Caffaro to Brescia. Illustrated detailed description of the installation on the falls of the river Caffaro, which provides power for soda works, and for general purposes. 1800 w. Elect'n, Lond—Feb. 14, 1908. Serial. 1st part. No. 90488 A.

The Brusio Power Plants and Power Distribution in Lombardy (Die Kraftwerke Brusio und die Kraftübertragung nach der Lombardei). The first part of the serial discusses the dam, sluices, etc., for this station in Italy. Ills. 2500 w. Serial. 1st part. Schweiz Bau—Jan. 4, 1908. No. 90357 B.

See also Water Powers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS; and Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Isolated Plants.

The Power Plant of a Newark Newspaper. Plan and description of the new power plant of the New Jersey "Freie Zeitung." 2500 w. Eng Rec—Feb. 22 1908. No. 90471.

Small Turbine Plants. Abstracts of papers by J. L. Hecht, and C. W. Pen Dell, read before the N.-W. Elec. Assn., bearing on the equipment and operation of small turbo-electric steam-driven plants. 2500 w. Elec Rev, N Y—Feb. 1, 1908. No. 89966.

See also Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Portable.

The "Energy Car," a Portable Generating Set (L' "Energy Car," Groupe Electrogène Transportable). J. A. Montpellier. Illustrated description of a truck carrying an internal-combustion motor, a dynamo, and a battery of accumulators. 2000 w. Electricien—Jan. 18, 1908. No. 90325 D.

Testing.

See Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

LIGHTING.

Arc Lamps.

Modern Arc Lighting. William A. Del

We supply copies of these articles. See page 158.

Mar. An account of modern developments in this field. Elec Age—Feb., 1908. No. 90040.

See Mechanical Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Incandescent Lamps.

A Comparison of the Effects of Frequency on the Light of Incandescent and Nernst Lamps. Frederick William Huels. An experimental study. 8000 w. Bul Univ of Wis, No. 157—May, 1907. No. 90415 C.

Transformers.

The Design of Small Transformers for Metallic Filament Lamps. F. B. O'Hanlon. Considers the manufacture of transformers by any one who has a lathe and the usual bench tools, showing how good results can be obtained. 3500 w. Elec Rev, Lond—Jan. 31, 1908. No. 90128 A.

MEASUREMENT.

Inductance.

Measurement of the Coefficient of Self-Induction of a Circuit Under Normal Load. C. C. Chapin. Suggests a method employing a differential alternating-current galvanometer, and a non-inductive resistance equal to that of the line. 1500 w. Elec Wld—Feb. 8, 1908. No. 90066.

Inductance Measurements. Albert Campbell. Also, "On the Use of Variable Mutual Inductances." The latter paper describes a special form of direct reading variable inductance and some of the uses. The first article discusses some of the points of interest, as a supplement to this paper. 3500 w. Elect'n, Lond—Feb. 7. 1908. No. 90250 A.

Instrument Testing.

The Testing of Electrical Instruments (Ueber Zählerprüfeinrichtungen). Ernst Kraus. Illustrates and describes methods and devices recently developed by Siemens and Halske. 4400 w. Elektrotech u Maschinenbau—Jan. 26, 1908. No. 90371 D.

Motor Testing.

The Hopkinson Test as Applied to Large Induction Motors. N. Pensabene-Perez. Describes a complete Hopkinson test as applied to four large induction motors. 1200 w. Elec Rev, Lond—Jan. 24, 1908. No. 90009 A.

Power Factor.

The Estimation of Power-Factor on Unbalanced Three-phase Loads. H. S. Baker. Explanation of a method found useful. 1000 w. Elec Age—Jan., 1908. No. 90038.

TRANSMISSION.

Line Construction.

Transmission Line Crossings Over Railroads. Ralph D. Mershon. Discusses possible dangers and methods of protection. 2200 w. R R Gaz—Feb. 7, 1908. No. 90080.

Line Design.

The Central Station Distributing System. H. B. Gear. An explanation of feeder calculations. 2000 w. Elec Age—Jan. 1908. No. 90039.

The Calculation of Electrical Transmission Lines (Statische Berechnung elektrischer Freileitungen). August Kann. A mathematical discussion of the stresses in transmission wires and the determination of sag, span, and size of wires. Ills. 2400 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—Jan. 24, 1908. No. 90363 D.

Motor Generators.

Motor Generators: Their Use and Operation. Norman G. Meade. Explains the applications to which they are suited, illustrating the manner in which the connections are made. 1600 w. Power—Feb. 11, 1908. No. 90152.

Poles.

Recent Experiments in Concrete Pole Construction with Figures of Cost. Gives results of studies of this material for poles, with editorial on the difficulties in handling them. 2500 w. Engng-Con—Jan. 29, 1908. No. 89937.

Consumption of Poles in 1906. Information based on the number of poles purchased. 2000 w. U S Dept of Agri—Circ 137. No. 90538 N.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Protective Devices.

The Protection of Electric Circuits and Apparatus from Lightning and Similar Disturbances. R. P. Jackson. The present article considers the causes and effects of static disturbances. Ills. 2000 w. Elec Jour—Feb., 1908. Serial. 1st part. No. 90425.

Transformers.

Systematic Testing of Oil in Transformers and Methods of Reclaiming Oil for Service. Illustrated description of methods. 1000 w. Elec Age—Jan., 1908. No. 90041.

The Berry Series Transformer Switch for Saving Light Load Losses. Illustrated detailed description of this system. 2000 w. Elec Engng—Feb. 6, 1908. No. 90247 A.

Wire Suspension.

A New Method of Supporting Overhead Conductors. Illustrates and describes the improved tangential suspension system of P. J. Pringle which overcomes many troubles. 2500 w. Elec Rev, Lond—Jan. 24, 1908. No. 90007 A.

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MISCELLANY.

Electric Shocks.

Electric Shocks. Henry M. Phillips. An explanation of the nature and dangers of electric currents. 4000 w. Cassier's Mag—Feb., 1908. No. 90278 B.

Peru.

Electricity in Peru. Emile Guarini. An account of the conditions, installations, education in electrical engineering, etc. 2000 w. Elec Rev, Lond—Feb. 7, 1908. No. 90248 A.

INDUSTRIAL ECONOMY

Contracts.

The Supply of Machinery and the Law (Die Machinenlieferung und das Gesetz). Rich. Wahle. A discussion of contracts and their performance in the purchase of machinery. 2000 w. Serial. 1st part. Technik u Wirtschaft—Jan., 1908. No. 90388 D.

Cost Systems.

Engine Costs. H. Weatherall. Abstract of a paper read before the N. E. Coast Assn. of Sec. Describes method used to compute cost from the workman's time sheet to the finished article. 5500 w. Ir & Coal Trds Rev—Feb. 14, 1908. No. 90507 A.

Labor-Cost Distribution at the General Electric Shops. George Frederic Stratton. A description of the interesting system used, giving the time card, and piece slip forms, and labor sheets. 2800 w. Engineering Magazine—March, 1908. No. 90576 B.

The Efficiency Method of Determining Costs to Eliminate All Wastes from Foundry Operations. Harrington Emerson. From an address delivered before the Pittsburg Found. Assn. Describes a system which gives valuable information concerning the cost of each operation, materials, etc., before the work is begun. 2000 w. Ir Trd Rev—Jan. 30, 1908. No. 89939.

Education.

Education and the Engineer. Editorial on the recent discussions at meetings of societies. 3500 w. Engr, U S A—Feb. 15, 1908. No. 90272 C.

Is Engineering to Become a Trade? Arthur L. Rice. A discussion of the requirements of industrial education. 5000 w. Sib Jour of Engng—Feb., 1908. No. 90437 C.

The Un-Academic Side of Engineering. Frank Foster. Considers the relation of academic studies to rational engineering, discussing features essential to success, that are un-academic. 3500 w. Mech Engr—Feb. 1, 1908. No. 90127 A.

The Making of an Electrical Engineer. George Frederic Stratton. Outlines the preparation given in the shops of the General Electric Co. 1600 w. Sci Am—Feb. 8, 1908. No. 90108.

Relation of the Mining School to the Mining Industry. Robert H. Richards. Read before the Am. Min. Cong. Brief discussion of the aims the school should have in view. 1500 w. Tech Qr—Dec., 1907. No. 90541 E.

Engineering Ethics.

The Engineer as a Man Among Men. Extracts from an address by Charles Whiting Baker at the dinner of the engineering graduates and students of the University of Vermont. 1800 w. Eng News—Feb. 20, 1908. No. 90411.

Filing Systems.

A System of Filing Engineering Notes and Records. Describes a system developed by Lewis C. Kelsey. 3000 w. Eng Rec—Feb. 8, 1908. No. 90098.

Labor.

The Amalgamated Society of Railway Servants. Outlines the scheme for conciliation and arbitration. 3000 w. Bul Int Ry Cong—Jan., 1908. No. 90289 E.

Cost of Living of the Working Classes. Abstracts from a recent report issued by the British Board of Trade on the cost of living in the industrial towns of the United Kingdom. 2800 w. Ir & Coal Trds Rev—Feb. 14, 1908. Serial. 1st part. No. 90508 A.

Enforced Idleness; Its Causes and Means of Preventing It or of Lessening Its Effects (Causes du Chamage Involontaire; Moyens de le Prévenir ou d'Atténuer ses Effets). Henri Lafranc. An economic discussion of the causes which lead to unemployment and the possible solutions of the problem. 3500 w. Rev d'Econ Indus—Jan. 16, 1908. No. 90301 D.

Municipal Ownership.

An American View of Municipal Trading. Reviews the report of the Commission upon Public Ownership and Operation appointed to investigate this subject in the United Kingdom and the United States. 3500 w. Engng—Feb. 7, 1908. Serial. 1st part. No. 90259 A.

Patents.

The Reform of the Patent Law. John William Gordon. Discusses clauses of the Amending Act of 1907, in England. Also general discussion. 13500 w. Jour Soc of Arts—Jan. 31, 1908. No. 90121 A.

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MARINE AND NAVAL ENGINEERING

Compasses.

The Empirical Compensation of the Mariner's Compass (Compensazione Empirica delle Bussole). Roberto M. de Bellegarde. A thorough description of the method. 2000 w. Rivista Marit—Jan., 1908. No. 90337 E + F.

Cruisers.

Cruisers—British and Foreign. A review of modern construction and armament. 2000 w. Engng—Feb. 7, 1908. No. 90256.

A German Motor Cruiser. Prof. Walter Mentz. From *Schiffbau.* Illustrated description of the "Oueslphalia." 900 w. Int Marine Engng—March 1908. No. 90510 C.

Dredges.

Hydraulic Dredge for Reclaiming Land for Lincoln Park, Chicago. Illustrated description of the dredge "Francis T. Simmons." 800 w. Eng News—Feb. 27, 1908. No. 90520.

Dry Docks.

Quay Walls for the New Dry Dock at the Charleston Navy Yard. Illustrates and describes the design and construction of exceptionally massive walls built of concrete, heavily reinforced with steel bars, and with buttresses on 15-ft. centers. 2200 w. Eng Rec—Feb. 1, 1908. No. 89959.

Hydroplanes.

The Crocco-Ricaldoni Hydroplane Boat. J. B. Van Brussel. Illustrates and describes an experimental boat, provided with hydroplanes only at the stem and stern. 500 w. Int Marine Engng—March, 1908. No. 90511 C.

Marine Transport.

The Work of Atlantic Liners. Editorial on the traffic and the recent scheme of fares which is likely to continue for three years. 1800 w. Engng—Feb. 14, 1908. No. 90499 A.

Motor Boats.

See Cruisers, under MARINE AND NAVAL ENGINEERING.

Oil Engines.

Paraffin Engine for Submarines. Illustrated description of this motor for the Italian Navy, with report of trials. 1400 w. Engr, Lond—Feb. 7, 1908. No. 90265 A.

Resistance.

A Note on the Theory of Ship's Resistance of H. Lorenz (Bemerkungen zur Schiffswiderstandstheorie von H. Lorenz). A mathematical discussion of H. Lorenz's article in the *Zeitschr. d. Ver. Deutscher Ing.* Ills. 1500 w. Serial. 1st part. Schiffbau—Jan. 8, 1908. No. 90358 D.

Shipbuilding.

The Interrelation of Theory and Practice of Shipbuilding. J. J. O'Neill. An examination of the speed-power aspect of the question. Plates. 5700 w. Inst of Engrs & Shipbldrs in Scotland—Jan. 21, 1908. No. 90555 N.

Modern Tendencies in Ship Building. J. Foster King, in *Glasgow Herald.* A review of progress and development. 3500 w. Marine Rev—Feb. 13, 1908. No. 90190.

Stability.

An Inclining Experiment. Harold F. Norton. Describes the process as performed on one of the late battleships, by which it is determined whether a ship will stand up straight and true when consigned to the water. 2200 w. Sib Jour of Engng—Feb. 1908. No. 90436 C.

Steamboats.

Stern-Wheel Steamer "Sultan" for the River Niger. Illustrated description of the vessel and its machinery. 1800 w. Engng—Jan. 31, 1908. No. 90141 A.

Steam Boilers.

Water-Tube Boilers in War Vessels (Die Wasserrohrkessel im Kriegschiffbetriebe). C. Strebel. Discusses various types of water-tube boilers and gives details and statistics of their use on war vessels. Ills. 6000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—Jan. 4, 1908. No. 90379 D.

Steam Engines.

Proportions of Parts of Triple-Expansion Engines. John Green. Calls attention to the advantages of these engines for marine work, and gives details of construction. 2000 w. Engr, U S A—Feb. 1, 1908. No. 89994 C.

Steamships.

The Steam Collier "Everett," for the New England Coal and Coke Company, Boston, U S A. Illustrations, plan, and brief description. 500 w. Engng—Feb. 7, 1908. No. 90257 A.

The Iron-Ore-Carrying Steamer "Polcirkeln." Illustrated description of a vessel recently built at Gothenburg. 300 w. Engng—Jan. 17, 1908. No. 90045 A.

The Twin-Screw Allan Liner "Corsican." Plate and description of a vessel illustrated in the Jan. 10th issue. 2000 w. Engng—Jan. 24, 1908. No. 90024 A.

The New Brazilian Liner Verdi. Illustrated description of a steamship, built in Belfast, to carry cargo and passengers between New York and South America. 1000 w. Int Marine Engng—March, 1908. No. 90509 C.

Steam Turbines.

See Torsion Meters, under MECHANICAL ENGINEERING, MEASUREMENT.

Submarines.

Italy's Progress in Submarine Navigation. Interesting details of boats of the submersible type for the Italian Government. 2500 w. Engr, Lond—Feb. 14, 1908. No. 90502 A.

See also Oil Engines, under MARINE AND NAVAL ENGINEERING.

Tank Steamers.

Safety Installations for Tank Steamers (Installations de Sécurité à Bord des Tanksteamers). M. M. Dibos. Discusses the transport of oil in bulk, its dangers, history, regulation, etc., and the construction of tank steamers to secure safety from fire, explosions, etc. Ills. 15000 w. Mem Soc Ing de France—Nov., 1902. No. 90304 G.

Torpedo Boats.

The Development of Torpedo Craft. Illustrations are given, showing the development of the speed element. Also describes H. M. S. "Tartar." 800 w. Cassier's Mag—Feb., 1908. No. 90280 B.

Tugs.

Two New Dialogue-Built Tugs for Service on the Pacific Coast. Illustrated description. 1000 w. Naut Gaz—Feb. 6, 1908. No. 90037.

New Harbor Tug for New Haven Railroad. Illustrated description of Transfer No. 21, constructed for the purpose of towing large steel car-floats between terminals. 500 w. Naut Gaz—Feb. 20, 1908. No. 90290.

MECHANICAL ENGINEERING

AUTOMOBILES.

Ail Cooling.

The Air Cooling of Cylinders (Beitrage zur Frage der Zylinderkühlung durch Luft). Herr Schwerdtfeger. A general discussion of the question. Ills. 4000 w. Zeitschr d Mit Motorwagen-Ver—Jan. 31 1908. No. 90373 D.

Cabs.

The Fiat Cab. Illustrated detailed description of this live-axle car. 1200 w. Auto Jour—Feb. 1, 1908. Serial. 1st part. No. 90123 A.

Carbureters.

The Evolution of the Petrol Carbureter. J. Wright. An illustrated article describing modern types showing the trend toward automatic action. 4000 w. Cassier's Mag—Feb., 1908. No. 90274 B.

Some of the Venturi Tube Peculiarities. E. A. Huene. Gives conclusions from a recent article by David Landau, showing the limitations of the Venturi tube carbureter, and suggests improvements. 1500 w. Automobile—Feb. 6, 1908. No. 90067.

Commercial Vehicles.

The Royal Light Delivery-Van. Illustrations with brief description. 400 w. Engng—Jan. 31, 1908. No. 90139 A.

See also Cabs, Omnibuses, and Road Trains, under AUTOMOBILES.

Competitions.

Across Three Continents by Automobile. An illustrated description of the cars and their equipment. 3000 w. Automobile—Feb. 13, 1908. No. 90170.

Coventry Humber.

The New 10-12 H. P. Coventry Humber. Illustrates and describes the more interesting features of this car. 1500 w. Autocar—Jan. 25, 1908. No. 90005 A.

De Dion.

The 12-H. P. Four-Cylinder De Dion Car. Begins a detailed description of this small four-cylinder car. Ills. 1000 w. Autocar—Feb. 15, 1908. Serial. 1st part No. 90482 A.

Designs.

Racing Influence on Touring Car Design. S. F. Edge. Abstract of a paper read before the Coventry Engng. Soc. Names the points essential to a luxurious modern touring-car and discusses how much racing may be credited with its evolution. 3000 w. Auto Jour—Feb. 1, 1908. No. 90125 A.

See also Roller Bearings, under MACHINE ELEMENTS AND DESIGN.

Electric.

See Front Driving, and Road Trains, under AUTOMOBILES.

Front Driving.

Front Driving. H. S. Hele-Shaw. Abstract of a paper read before the Incor. Inst. of Auto. Engrs. With special reference to electric and hydraulic transmission. 2000 w. Auto Jour—Jan. 25, 1908. Serial. 1st part. No. 90003 A.

The Front Driving of Steam and Petrol Vehicles. R. W. Harvey Bailey. Abstract of a paper read before the Inst. of Auto. Engrs. A study of the effect of the application of the propelling force on the stability of the vehicle. 2000 w. Auto Jour—Jan. 25, 1908. Serial. 1st part. No. 90004 A.

Garages.

Generating Station, Garage and Equipment of the Auto Transit Company of

Philadelphia, Pa. Illustrated detailed description of plant and vehicle equipment. 2000 w. Elec Wld—Feb. 22, 1908. No. 90299.

Gasoline Meter.

A Gasoline Meter for Automobile Use. Illustrated description, with explanation of the principle on which it is based. 1500 w. Automobile—Feb. 6, 1908. No. 90068.

Gears.

Gear Arrangements and Ratios in Motor-Cars. Gives method of calculating the efficiency of various arrangements, and discusses the problem of getting the greatest speed over varying roads out of a given sized engine. 3000 w. Engng—Jan. 31, 1908. No. 90136 A.

Gregoire.

The 10-14 H. P. Gregoire. Illustrated description of this light car. 1200 w. Autocar—Feb. 1, 1908. No. 90122 A.

Ignition.

High-Tension Magneto Ignition Systems. Illustrated description of the Mira magneto. 2000 w. Auto Jour—Feb. 15, 1908. No. 90480 A.

Methods of Testing Igniting Apparatus. F. W. Springer. Gives simple methods found convenient by the writer. 1800 w. Elec Wld. Feb. 15, 1908. No. 90160.

Motors.

Sound Features of 1908 Engines. G. H. Baillie. Abstract of a paper read before the Royal Auto. Club. Information of details collected at the Olympia Show, and since. 2500 w. Auto Jour—Feb. 1, 1908. Serial. 1st part. No. 90126 A.

Omnibuses.

Automobile as a Railroad Connection. Illustrations and brief description of vehicles recently put in service in Paris. 700 w. Automobile—Feb. 20, 1908. No. 90443.

Electric Omnibuses in London (Die elektrischen Omnibusse in London). Herbert Bauer. Describes the cars of the Electrobus Company, methods of operation, costs, etc. Ills. 3600 w. Zeitschr d Mit Motorwagen-Ver—Jan. 31, 1908. No. 90372 D.

Repairing.

Problems in the Repairing of Automobiles. Thomas J. Fay. The present number deals mainly with the materials used and the importance of quality. Micrographs. 2800 w. Automobile—Feb. 20, 1908. Serial. 1st part. No. 90444.

Road Trains.

The Sampson Gas-Electric Road Train. Illustrated description. 600 w. Sci Am—Feb. 15, 1908. No. 90196.

Roydale.

The Roydale Petrol Cars. The 18-22 h. p. car is described in detail. Ills. 1000 w. Auto Jour—Feb. 1, 1908. Serial. 1st part. No. 90124 A.

Stevens-Duryea.

Stevens-Duryea Cars. Illustrates and describes the "Big-Six" and "Light-Six" models. 1200 w. Automobile—Jan. 30, 1908. No. 89938.

Transport.

Motor Transport for the Colonies. John Wells. An illustrated account of experiences in Egypt. 1400 w. Autocar—Feb. 8, 1908. Serial. 1st part. No. 90240 A.

COMBUSTION MOTORS.

Exhaust.

The Exhaust of the Internal-Combustion Engine. H. Addison Johnston. Discusses causes of trouble. 2000 w. Power—Feb. 25, 1908. No. 90463.

Gas Conduits.

A Simple Method of Cleaning Gas Conduits. W. D. Mount. Sketches and description of a system developed for cleaning without interruption to producers, conduits and furnaces. 1200 w. Pro Am Soc of Mech Engrs—Feb., 1908. No. 90531.

Gas Engine Governing.

Progress of European Governors. George B. Massey, 2d. Illustrates and describes designs for gas engine regulation. 1500 w. Cassier's Mag—Feb., 1908. No. 90277 B.

Gas Engine Lubrication.

Lubrication of the Larger Sizes of Gas Engines. R. R. Keith. On the requirements, the original method of lubrication, construction of the oil pump and its action. Ills. 1800 w. Power—Feb. 18, 1908. No. 90231.

Gas Engines.

Some Features of the Internal-Combustion Motor Problem. Joseph H. Hart. Considers the full preparation, air advent, production of the heat, etc. 2500 w. Power—Feb. 11, 1908. No. 90150.

Third Report to the Gas-Engine Research Committee. Prof. Frederic W. Burstall. Devoted to a consideration of compression and efficiency. 2 appendices. 8 plates. 7500 w. Inst of Mech Engrs—Jan. 17, 1908. No. 90022 N.

The Construction and Working of Large Gas Engines. P. R. Allen. Abstract of a paper read before the Manchester Assn. of Engrs. A review of the development and description of present practice. Ills. 6500 w. Engng—Feb. 14, 1908. No. 90500 A.

Gas Engine Guarantees Technically Considered. William T. Magruder. Outlines the history of the gas engine from 1680, and considers engine guarantees. 4000 w. Gas Engine—Feb., 1908. No. 90179.

We supply copies of these articles. See page 158.

See also Blowing Engines, and Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Gasoline Engines.

A Novel Petrol Engine. Illustrated description of the Roche engine. 1200 w. Autocar—Feb. 8, 1908. No. 90239 A.

Novel Type of Two-Stroke Engine. Illustrated description of an engine exhibited at the Chicago show, known as the "Twice-Two Cycle." 1500 w. Rudder—Feb., 1908. No. 90025 C.

Gas Power Plants.

See Power Plants, under POWER AND TRANSMISSION.

Gas Producers.

The Rational Utilization of Low-Grade Fuels. Discussion of F. E. Junge's paper on this subject. 7500 w. Pro Am Soc of Mech Engrs—Feb., 1908. No. 90533 C.

The Destruction of Tar in Gas-Producers. H. P. Bell. Reviews and criticises the more important devices adopted or proposed, and discusses the conditions necessary for success. Ills. 3000 w. Engng—Jan. 31, 1908. Serial. 1st part. No. 90138 A.

See also Gas Conduits, under COMBUSTION MOTORS.

Gas Testing.

A Method for the Continuous Testing of the Calorific Value of Gases and Gaseous Mixtures (Procédé d'Evaluation Permanente de la Valeur Calorifique des Gaz et Mélanges Gazeux). A. Adam. Illustrates and describes a simple apparatus for testing gas for engines, furnaces, etc. 1200 w. Rev de Métal—Jan., 1908. No. 90315 E + F.

Gas Turbines.

See Steam Turbines, under STEAM ENGINEERING.

Oil Engines.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Oil Engines, under MARINE AND NAVAL ENGINEERING.

Producer Gas.

See Furnaces, under MACHINE WORKS AND FOUNDRIES.

HEATING AND COOLING.

Refrigeration.

A Problem in Refrigeration. Arthur J. Wood. Considers heat losses in an ammonia compression system, and their cause. 1500 w. Ice & Refrig—Feb., 1908. No. 90070 C.

Ammonia in Refrigeration. Joseph H. Hart. Explains why ammonia is so efficient in producing artificial cold. 2500 w. Cassier's Mag—Feb., 1908. No. 90279 B.

Starting an Absorption System After Overhauling. William S. Luckenbach. Gives useful hints. 1500 w. Engr, U S A—Feb. 15, 1908. No. 90270 C.

Comparison of Bids for Ice Making and Refrigerating Machinery. Charles E. Lucke. Discusses factors to be considered by the producer of refrigerating machinery. 3500 w. Ice & Refrig—Feb., 1908. Serial. 1st part. No. 90069 C.

Ice Skating Rink for Boston. Illustrated description of a proposed ice skating rink, hippodrome, ice-making and cold-storage plant to be erected. 600 w. Ice & Refrig—Feb., 1908. No. 90071 C.

See also Mechanical Plants, under POWER AND TRANSMISSION.

Steam Heating.

See Boiler Rating, Fuels, and Steam Receivers, under STEAM ENGINEERING.

Ventilation.

The Why of Warming and Ventilating. W. H. Cosmey. Second prize paper of the Inst. of Heat. & Vent. Engrs., England. The present article discusses mainly the effect on the health. 2000 w. Met Work—Feb. 22, 1908. Serial. 1st part. No. 90438.

See also Mechanical Plants, under POWER AND TRANSMISSION.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Simplest Analytical and Graphical Methods for the Design of Centrifugal Pumps (Zusammenstellung der einfachsten analytischen und graphischen Lösungen zur Berechnung der Zentrifugalpumpen). Albert Achenbach. Ills. 2000 w. Die Turbine—Jan. 20, 1908. No. 90376 D.

Pumping Plants.

Lawrence Avenue Pumping Station, Chicago, Ill. An illustrated description of a station for transferring north side sewage to the river. 2500 w. Engr, U S A—Feb. 15, 1908. No. 90269 C.

Efficiency Test of a Pumping Plant Used for Rice Irrigation. W. B. Gregory. Describes a test made to determine the efficiency and fuel economy of the pumping plant of the Jennings Canal Co., about two miles east of Jennings, La. 1200 w. Sib Jour of Engng—Feb., 1908. No 90435 C.

See also Irrigation, under CIVIL ENGINEERING, WATER SUPPLY.

Pumps.

The Emerson Steam Pump. Illustrates and describes the pump and its operation. 1500 w. Ir Age—Feb. 6, 1908. No. 90051.

Turbine Governing.

Turbine Governors (Turbinenregler). Paul H. Muller. A complete discussion of methods and devices for the governing of hydraulic turbines. Ills. 1600 w. Se-

rial. 1st part. Zeitschr f d Gesamte Turbinenwesen—Jan. 10, 1908. No. 90374 D.

Turbines.

Notes on the Purchase and Use of Hydraulic Turbines. W. Kennedy, Jr. Compares European and American methods of turbine design. Ills. and discussion. 4500 w. Can Soc of Civ Engrs, Bul No 2—Dec., 1907. No. 90543 N.

Water Wheels.

Speed Regulation of High-head Water Wheels. H. S. Knowlton. On the difficulties and methods of regulating, and calculating speed, as explained in a recent paper by Henry E. Warren. 2000 w. Eng & Min Jour—Feb. 15, 1908. No. 90212.

MACHINE ELEMENTS AND DESIGN.

Cams.

Friction of Cams. Con. T. Wise. An explanation of the forces acting on a cam. 1000 w. Am Mach—Vol. 31. No. 6. No. 90054.

Laying Out Cams for Rapid Motions. F. H. Sibley. Explains the elements of cam mechanisms and gives sketches illustrating how the principle may be applied. 1500 w. Mach N Y—Feb., 1908. No. 90062 C.

Chains.

See Beams, under CIVIL ENGINEERING, CONSTRUCTION.

Drafting.

Standard Drawing-Room Methods. M. R. Kavanagh. Suggests features of value, giving tables of data, etc. 1500 w. Mach, N Y—Feb., 1908. No. 90060 C.

Roller Bearings.

Self-Aligning Taper Roller Bearings. H. W. Alden. Read before the Soc. of Auto. Engrs. at N. Y. Concerning the design and action of certain forms of roller bearings, illustrating their application to automobile conditions. Ills. 1000 w. Automobile—Feb. 27, 1908. No. 90565.

Screws.

Screw Thread Systems. Erik Oberg. Reviews systems used in the United States and Europe. 2500 w. Mach, N Y—Feb., 1908. No. 90061 C.

MACHINE WORKS AND FOUNDRIES.

Auger Making.

Auger Making in an Old American Shop. Methods at the Pugh works, in Philadelphia, are illustrated and described. 1500 w. Am Mach—Vol. 31. No. 8. No. 90403.

Boring Machines.

Boring Multiple Cylinders. E. J. McKernan. Illustrated description of the Jacobs rapid universal locomotive cylinder machine used at the Topeka shops of the Santa Fé. 1000 w. Ir Age—Feb. 27, 1908. No. 90527.

Brass Founding.

Use of Cothias Metal for Castings. Emil B. Horne. Suggestions for brass foundrymen in regard to the use of this alloy. Ills. 1000 w. Foundry—Feb., 1908 No. 89956.

The Manufacture of Ingot Brass and the Advantages and Disadvantages in Its Use. An illustrated article giving information concerning this material and the uses for which it is suited. 3500 w. Brass Wld—Feb., 1908. No. 90548.

Cam Cutting.

Two Methods of Making Master Cams. William V. Lowe. One method cuts them on a milling machine without laying them out; the other uses a blackened zinc templet. 2000 w. Am Mach—Vol. 31. No. 9. No. 90513.

Case Hardening.

Case-Hardening Steel with Gas. E. F. Lake. Illustrated description of difficult pieces carbonized, and the construction of the furnace with its gas tank. 3000 w. Am Mach—Vol. 31. No. 8. No. 90400.

New Applications of Case-Hardening. Phillip C. Osterman. Suggests improved method and recommends many new applications. 1800 w. Am Mach—Vol. 31. No. 7. No. 90158.

Castings.

Sixteen Ways to Lose a Casting. Wilber R. Tilden. Discusses the general causes of bad castings, and the 16 defects due to opposite faults. Ills. 3000 w. Ir Age—Feb. 20, 1908. No. 90298.

Production of Malleable Castings. Richard Moldenke. The first of a series of articles aiming to discuss every phase of the malleable process. 3000 w. Foundry—Feb., 1908. Serial. 1st part. No. 89949.

The Production of Malleable Castings. Richard Moldenke. The first of a series covering every phase of the malleable process. 3000 w. Ir Trd Rev—Feb. 13, 1908. Serial. 1st part. No. 90171.

The Method of Producing Die Castings. E. Luther Lake. Illustrates and describes the process, also the molds, melting pots, casting machines, and some of the castings. 2000 w. Am Mach—Vol. 31. No. 7. No. 90155.

Core Drying.

Drying Moulds and Cores. E. L. Rhead. Considers the methods and requirements of ovens, their situation, etc. Ills. 2000 w. Mech Engr—Feb. 14, 1908. No. 90485 A.

Cupolas.

The Consumption of Coke in Cupolas (Zur Frage des Koksaufwandes bei Kupolöfen). Georg Buzek. A discussion of the various agencies affecting it. 2800 w. Serial. 1st part. Stahl u Eisen—Jan. 29, 1908. No. 90348 D.

We supply copies of these articles. See page 158.

Cutting Tools.

See Tool Steels, under MATERIALS OF CONSTRUCTION.

Fire Protection.

The Prevention of Fire in Factories (Les Moyens employés dans les Ateliers pour se Défendre contre l'Incendie). Practical suggestions for all branches of industry though relating particularly to the fire-protection system of a textile factory. 5000 w. Rev d'Econ Indus—Jan. 16, 1908. No. 90300 D.

Foundries.

A Foundry Business on the Pacific Coast. H. Cole Estep. Brief illustrated description of the Union Iron Works, Spokane, Wash. 1500 w. Ir Trd Rev—Feb. 6, 1908. No. 90072.

Foundry Practice.

The Application of Science to Foundry Work. Robert Buchanan. Discusses moulds, melting, mixtures of iron for the cupola, methods of making castings, etc. General discussion. 8500 w. Jour Soc of Arts—Feb. 14, 1908. No. 90479 A.

See also Brass Founding, Castings, Core Drying, Furnace Charging, Molding, Pipe Founding, and Pneumatic Tools, under MACHINE WORK AND FOUNDRIES.

Furnace Charging.

Annealing-Furnace Charging Machine. Illustrated description of a pneumatic machine designed to replace hand trucks. 1000 w. Foundry—Feb., 1908. No. 89950.

Furnaces.

Air Supply to Furnaces. W. H. Booth. Discusses briefly good and bad practice. 1000 w. Power—Feb. 4, 1908. No. 89998.

Air Blast Gas Appliances. Papers by W. K. Eavenson, W. H. Allen, and S. Tully Wilson presented at meeting of the Am. Gas Inst., and discussed together. Ills. Deals with industrial gas appliances. 10500 w. Pro Age—Feb. 15, 1908. Discussion to be continued. No. 90213.

Air Blast Gas Appliances. Papers by W. K. Eavenson, W. H. Allen, and S. Tully Wilson, read before the American Gas Institute, and discussed. Ills. 11500 w. Am Gas Lgt Jour—Feb. 3, 1908. No. 89973.

The Advantages of Producer Gas-Firing. Dr. Oskar Nagel. Illustrates and describes gas producers and direct-fired furnaces, stating the advantages claimed. 2500 w. Cassier's Mag—Feb., 1908. No. 90276 B.

Melting, Heating, Dissolving and Eluting. Oskar Nagel. Illustrates and describes appliances and methods used. 2000 w. Elec Chem & Met Ind—Feb., 1908. Serial. 1st part. No. 90029 C.

See also Case Hardening, and Core Drying, under MACHINE WORKS AND FOUNDRIES.

Gages.

Making Thread Gages. A. L. Monrad. A method is illustrated and described. 2500 w. Mach, N Y—Feb., 1908. No. 90063 C.

Gear Cutting.

M. Louis Boisard's Method of Cutting Spur, Helicoidal and Bevel Gears (Comment M. Louis Boisard taille au Hob des Engrenages droits, hélicoidaux et coniques). J. Germain. Illustrates a new gear-hobbing machine. 4000 w. All Indus—Jan., 1908. No. 90329 D.

Grinding.

Grinding Cone Pulleys. J. H. Hollinger. Illustrates the machine used and the pulleys, giving description of work. 900 w. Am Mach—Vol. 31. No. 7. No. 90156.

Machine Tools.

Some Interesting Antique Machine Tools. E. A. Dixie. Illustrated description of an old lathe, made 74 years ago, showing modern features. 1500 w. Am Mach—Vol. 31. No. 9. No. 90516.

Reversing Mechanisms for Machine Tools. Luther D. Burlingame. An illustrated review of devices used on various types of machines. 2800 w. Am Mach—Vol. 31. No. 6. Serial. 1st part. No. 90052.

Management.

Routing Work Through the Shop. Describes the system used by the R. K. Le Blond Machine Tool Co. 1200 w. Ir Trd Rev—Feb. 27, 1908. No. 90562.

Methods of Ordering and Routing Work. Oscar E. Perrigo. Fifth of a series of articles on cost-keeping and shop management. 3000 w. Ir Trd Rev—Feb. 6, 1908. No. 90073.

The Production System of the Westinghouse Electric and Mfg. Company. H. M. Wharton. Describes the methods used by the departments directly concerned in creating the product, outlining only the general method of procedure. 4000 w. Engineering Magazine—March, 1908. No. 90571 B.

The Fundamental Principles of Works Organization and Management. P. J. Darlington. The first of two articles discussing the elements of organization and management. 4000 w. Engineering Magazine—March, 1908. No. 90579 B.

The Engineer and the Economics of Management (Ingenieur und Wirtschaftspraxis). Emil Schiff. Shows how largely economic considerations influence engineering problems of all sorts. 2000 w. Technik u Wirtschaft—Jan., 1908. No. 90387 D.

The Engineer and the Science of Management (Der Ingenieur und die Verwaltungswissenschaften). Prof. W. Franz.

We supply copies of these articles. See page 158.

Discusses the necessity for academic training in industrial management. 1600 w. Serial. 1st part. Technik u Wirtschaft—Jan., 1908. No. 90386 D.

Milling Machines.

Double-Head Milling and Profiling Machine. Illustrated description of a high-speed vertical spindle machine of large size made in Manchester, Eng., for a British Colonial railway. 800 w. Engng—Feb. 14, 1908. No. 90496 A.

Molding.

Molding a Four-way Stand Pipe. George Buchanan. Illustrates and describes the method used. 900 w. Am Mach—Vol. 31. No. 9. No. 90514.

Molding a Large Cylinder Casting. C. R. McGahey. A method pursued in a southern jobbing foundry is illustrated and described. 700 w. Foundry—Feb., 1908. No. 89951.

A Method of Molding a Web Pulley. W. W. McCarter. Illustrates and describes the method used. 1500 w. Foundry—Feb., 1908. No. 89953.

Molding Machines.

Machine Molded Drop Hangers. Illustrates and describes successful molding practice. 1500 w. Foundry—Feb., 1908. No. 89952.

Pattern Making.

A Few Pattern Shop Sanding Schemes. H. N. Tuttle. Diagrams and descriptions. 2500 w. Foundry—Feb., 1908. No. 89954.

Pattern Shops.

Organization of the Pattern Shop. Oscar E. Perrigo. Considers the arrangement of the machinery and the division of the working force. 2500 w. Foundry—Feb., 1908. No. 89955.

An Uncommon Type of Pattern-Shop. H. J. Kennedy. A shop designed and built in 8 weeks, at Sparrow's Point, Maryland, is illustrated and described. Also some useful devices installed. 3000 w. Am Mach—Vol. 31. No. 6. No. 90055.

Pipe Founding.

Casting Direct from the Blast Furnace in Pipe Founding (Der unmittelbare Guss vom Hochofen insbesondere in Rohrgiessereien). Carl Irresberger. A review of the development of this process and present practice. 3500 w. Stahl u Eisen—Jan. 22, 1908. No. 90347 D.

Pneumatic Tools.

The Applications of Compressed Air in Foundry Practice (Ueber Verwendung von Pressluft im Giessereibetriebe). Otto S. Schmidt. Illustrates various applications to moulding machines, sieves, cleaning devices, etc. 4000 w. Stahl u Eisen—Jan. 1, 1908. No. 90343 D.

Screw Cutting.

Forming Tools for Automatic Screw Machines. C. L. Goodrich and F. A. Stanley. Diagrams and descriptions of the making of circular and dovetail forming tools and applying them to screw machine work. 4000 w. Am Mach—Vol. 31. No. 9. No. 90512.

Shop Practice.

Some Contrivances from Sparrow's Point. H. J. Kennedy. Illustrated descriptions of a tool for packing condenser tubes, kerosene-burning heaters for shrink fits, a thermit weld, etc. 1000 w. Am Mach—Vol. 31. No. 7. No. 90159.

Machining Cylinders in a Glasgow Shop. Henry Munro. Illustrates and describes methods and tools used in making engines for heavy motor vehicles. 4000 w. Am Mach—Vol. 31. No. 8. No. 90401.

Machining Oil-Country Gas-Engine Cylinders. W. Osborne. Devices used and the different turning and boring operations are illustrated and described. 1200 w. Am Mach—Vol. 31. No. 6. No. 90053.

Shops.

The Felten and Guilleaume-Lahmeyerworke A.-G., Frankfort. Illustrated description of these works for the construction of electrical machinery. 3300 w. Engng—Jan. 24, 1908. No. 90023 A.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Tools.

Automatic Screw-Machine Turning Tools. C. L. Goodrich and F. A. Stanley. Explains how box tools with tangent and radial cutters and hollow mills are made and applied. Ills. 3000 w. Am Mach—Vol. 31. No. 6. No. 90056.

Welding.

The Alumino-Thermic Welding Process. A. I. Graham. Lecture before the S. Wales Inst. of Engrs. Outlines the general idea of the process and some of its applications. 1800 w. Mech Engr—Feb. 7, 1908. No. 90245 A.

Woodworking Machines.

Ransome's Electrically-Driven Squaring-Up Machine. Illustrated description of a machine for squaring-up logs of hard timber. 600 w. Engng—Jan. 17, 1908. No. 90046 A.

New Woodworking Machines (Neuere Holzbearbeitungsmaschinen). Illustrates and describes new machines made by C. L. P. Fleck's Sons, Berlin. 1800 w. Serial. 1st part. Zeitschr f Werkzenz—Jan. 25, 1908. No. 90362 D.

See also Electric Driving, under POWER AND TRANSMISSION.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Beginnings of the Metallurgy of Tungsten (Les Débuts de la Métallurgie du Tungstène). Paul Nicolardot. A review of the earliest researches on the properties of iron-tungsten alloys. 7500

w. Rev de Métal—Jan., 1908. No. 90313 E + F.

Bearing Metals.

Alloys for Railroad Bearings. G. H. Clamer. Presented at meeting of the Am. Soc. for Test. Mat. Reviews the history and development of these mixtures in the United States. 3500 w. Foundry—Feb., 1908. No. 89957.

Ferro-Alloys.

See same title, under MINING AND METALLURGY, IRON AND STEEL.

Metallography.

Observations on Recalescence Curves. W. Rosenhain. Abstract of a paper read before the Physical Soc. of London. Describes methods of obtaining these curves, and remarks on their importance in the study of metals and alloys. 2000 w. Engng—Feb. 7, 1908. No. 90258 A.

The Application of the Diagram of Equilibrium of the Iron-Carbon System to the Structure and Heat Treatment of Steels and Cast Iron (Applications du Diagramme d'Equilibre du Système Fer-Carbone à la Constitution et au Traitement Thermique des Aciers et des Fontes). A. Portevin. Ills. 4000 w. Rev de Métal—Jan., 1908. No. 90314 E + F.

Steel.

The Work Shop Treatment of Steel. Walter Rosenhain. From the Engng. Sup. of the *London Times*. Considers the effect of punching, dangers of caulking, action of a cutting tool, etc. 2000 w. Ir Trd Rev—Feb. 20, 1908. No. 90420.

Alterations of Steel in Heat-Treating. J. E. Storey. Gives tabulated and charted results of the expansion and contraction of steel with different degrees of temperature in hardening. 2500 w. Am Mach—Vol. 31. No. 8. No. 90402.

The History of Knowledge of Steel (Note sur l'Historie de la Connaissance de l'Acier). Carl Benedicks. A review of the growth of knowledge of the distinction between steel and wrought iron and of their properties. 2000 w. Rev de Métal—Jan., 1908. No. 90312 E + F.

Tool Steels.

The Treatment of High-Speed Steel. Ethan Viall. Discusses the treatment of various brands. 2500 w. Am Mach—Vol. 31. No. 9. No. 90515.

MEASUREMENT.

Pyrometry.

The New Chauvin and Arnoux Thermo-Electric Industrial Pyrometers (Nouveau Pyromètres Thermo-Electriques Industriels de MM. Chauvin et Arnaux). M. Aliamet. Illustrated detailed description. 3000 w. Serial. 1st part. Electricien—Jan. 25, 1908. No. 90327 D.

Standards.

The International Bureau of Weights and Measures. Herbert T. Wade. Explains the importance of this Bureau, located near Paris, illustrating and describing the work and some of the instruments. 1200 w. Sci Am—Feb. 8, 1908. No. 90109.

The International Bureau of Weights and Measures (Le Bureau International des Poids et Mesures). Ed. Guillaume. A description of its functions, equipment, and achievements. 3000 w. Bul Soc Int d'Elecns—Jan., 1908. No. 90311 F.

Torsion Meters.

Torsion Meters for Marine Steam Turbines. J. Hamilton Gibson. Examines and describes some of these ingenious instruments. Ills. 2000 w. Mech Engr—Feb. 7, 1908. Serial. 1st part. No. 90246 A.

POWER AND TRANSMISSION.

Air Compressors.

Setting the Valve-Gear of Air Compressors. Claude Aikens. Considers the importance of piston clearance; how to determine positions of crank-pin and eccentric; setting blowing-engine valves, etc. Ills. 2500 w. Power—Feb. 18, 1908. No. 90229.

See also Turbo-Compressors, under POWER AND TRANSMISSION.

Compressed Air.

The Transmission of Compressed Air (Note sur les Canalisations d'Air sous Pressions Elevées). M. G. Leroux. A theoretical and practical discussion of the design and construction of pipe lines for the transmission of compressed air. Ills. 10000 w. Mem Soc Ing Civ de France—Oct., 1907. No. 80302 G.

Investigations on the Friction of Gases in Cylindrical Pipes (Untersuchungen über den Strömungswiderstand der Gase in geraden zylindrischen Rohrleitungen). Herr Fritzsche. Gives in curves and tables the results of very extensive experiments. Ills. 9000 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1908. No. 90382 D.

Electric Driving.

Installation and Care of Electric Motors. Norman G. Meade. Practical advice on the installation, maintenance, and care of motors. Ills. 1000 w. Power—Feb. 18, 1908. Serial. 1st part. No. 90230.

The Electric Drive of a Woodworking Plant. Illustrated description of the application of electric motors to a plant engaged in the manufacture of lumber, sashes, doors, interior finish, etc. 2000 w. Wood Craft—Feb., 1908. No. 89975.

Development of Textile Electric Driving. J. Shaw. Discusses the advantages and advocates obtaining the power from a supply company. 1200 w. Elect'n, Lond—Feb. 7, 1908. No. 90251 A.

We supply copies of these articles. See page 158.

The Application of Electric Power to Pulp and Paper Mills—The Watab Pulp and Paper Company's Mill. LeRoy M. Harvey. Explains the advantages claimed for electric power, and gives brief illustrated description of this plant at Sartoll, Minn. 4500 w. Elec Rev, N Y—Feb. 22, 1908. No. 90418.

Rolling Mills and Winding Engines Operated by Thury Motors. Illustrated description of the system of M. Thury on the principle of constant current at variable pressure. 2000 w. Elec Rev, Lond—Jan. 24, 1908. No. 90008 A.

Novel Electric Drive for Rolling Mills. Illustrates and describes an application of electric motors at the plant of the Illinois Steel Co., South Chicago. A small motor drives the rolls during the passes by utilizing the stored energy of a heavy fly-wheel. 1700 w. Power—Feb. 4, 1908. No. 89996.

The Electric Drive of a Large Rolling Mill. W. A. Dick. Illustrated description of the apparatus used in a recent application to a large rolling mill of the Illinois Steel Co., at South Chicago. 2000 w. Elec Jour—Feb., 1908. No. 90424.

Electric Driving at the Angleur Steel Works (Installations Electriques des Aciéries d'Angleur). Illustrates and describes the electric driving of punches, rolls, and other machines at these works. 7500 w. Soc Belge d'Elecns—Jan., 1908. No. 90307 E.

Some Applications of Electric Driving (Quelques Applications de la Commande Electrique). L. Finn. Discusses the driving of machine tools, paper mills, cotton printing mills, etc. Ills. 2500 w. Electricien—Jan. 25, 1908. No. 90326 D.

See also Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Lubricants.

See Boiler Waters, under STEAM ENGINEERING.

Lubrication.

See Gas Engine Lubrication, under COMBUSTION MOTORS.

Mechanical Plants.

Mechanical Plant of the Worcester Cold Storage & Warehouse Company. Howard S. Knowlton. Illustrated description. 2000 w. Eng Rec—Feb. 8, 1908. No. 90069.

Heating and Ventilating a Modern Department Store. John G. Eadie. Illustrated description of the mechanical equipment of the new Altman building, in New York. 4500 w. Heat & Vent Mag—Feb., 1908. No. 90552.

Electrical Equipment of the New York Custom House. H. Thurston Owens. Illustrated detailed description of the equipment of a building costing over $7,000,000. 1600 w. Elec Wld—Feb. 8, 1908. No. 90064.

Power Plants.

A Modern Factory Power Plant. Illustrates and describes the new plant of the Cleveland Twist Drill Company. 2000 w. Ir Age—Feb. 6, 1908. No. 90050.

Steam or Electrically Driven Auxiliaries. Frank Koester. Considers the efficiency of the different apparatus, and first cost, maintenance and convenience of operation. Ills. 2200 w. Elec Rev, N Y—Feb. 8, 1908. No. 90092.

Power Equipment for the Small Factory. Percival Robert Moses. Discusses the factors of importance for convenience and economy in manufacture. Ills. 5000 w. Engineering Magazine—March, 1908. No. 90572 B.

Calculations for Power Plants. Dr. Franz H. Hirschland. Gives a comparison of steam, gas, and hydro-electric power for a given case. 2500 w. Elec Chem & Met Ind—Feb., 1908. No. 90028 C.

Testing of Steam Electric Power Plants. Frank Koester. The first of a series of articles on methods of conducting tests of such plants. Ills. 1500 w. Elec Rev, N Y—Feb. 22, 1908. Serial. 1st part. No. 90417.

Turbo-Compressors.

Turbo-Blowers for Blast Furnaces (Ueber Hochofen-Turbinengebläse). P. Langer. Describes the various machines and their operation. Ills. 3200 w. Stahl u Eisen—Jan. 15, 1908. No. 90346 D.

STEAM ENGINEERING.

Boiler Explosions.

Greenwich Boiler Explosion. A report of the Board of Trade inquiry into the cause of the explosion of a thermal storage drum on a Babcock & Wilson boiler at the Greenwich station of the South Metropolitan Power Co. 1700 w. Engr, Lond—Jan. 17, 1908. Serial. 1st part. No. 90016 A.

Boiler Fittings.

Water-Column Connections. W. H. Wakeman. Suggestions for the care and testing of water-columns and connections. Ills. 2000 w. Power—Feb. 4, 1908. No. 89997.

Approved Safety Stand Pipes for Low-Pressure Steam Boilers (Genehmigte Sicherheits - Standrohrvorrichtungen für Niederdruckdampfkessel). Johann Irnoosky. Illustrates and describes types accepted by the Austrian Minister for Commerce. 7000 w. Oest Zeitschr f d Oeffent Baudienst—Jan. 18, 1908. No. 90364 D.

Boiler Management.

See Smoke Prevention, under STEAM ENGINEERING.

Boiler Plates.

Heat Stresses and the Formation of Cracks. Carl Sulzer. Trans. from *Zeit. des Ver. Deut. Ing.* Illustrates and describes a case which offers a striking example of the formation of cracks by heat stresses, discussing the causes. 3300 w. Boiler Maker—Feb., 1908. No. 89948.

Boiler Rating.

Rating House Heating Boilers. Methods proposed by Prof. William Kent. Presented at meeting of the Am. Soc. of Heat. & Vent. Engrs. 900 w. Eng Rec—Feb. 15, 1908. No. 90206.

Boilers.

A New Water-tube Boiler. Illustrated description of the Hay water-tube boiler, which has new features of interest. 700 w. Engr, Lond—Feb. 14, 1908. No. 90506 A.

See also Steam Boilers, under MARINE AND NAVAL ENGINEERING.

Boiler Waters.

Simple Methods of Testing Feed-Water and Lubricants. James E. Noble. Suggests methods for testing and treating feed-water and lubricants for use in the steam plant. 2000 w. Prac Engr—Feb. 7, 1908. No. 90242 A.

Water for Economical Steam Generation. J. C. William Greth. Shows the actual savings effected by obtaining a proper water supply to feed the boilers, giving statements of actual cases under working conditions. Ills. 4000 w. Engineering Magazine—March, 1908. No. 90573 B.

See also Feed-Water Heaters, under STEAM ENGINEERS.

Engine Design.

See Pistons, and Piston Speeds, under STEAM ENGINEERING.

Engines.

See Steam Engines, under MARINE AND NAVAL ENGINEERING: Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL; and Hoisting Engines, under MINING AND METALLURGY, MINING.

Engine Troubles.

Causes of Knocks in Steam Engines. C. J. Larson. Explains some of the causes and gives directions for preventing them. 2200 w. Power—Feb. 11, 1908. Serial. 1st part. No. 90149.

Entropy.

The Question of Entropy. Sidney A. Reeve. A review of the recent discussion in British journals concerning the proper definition of the term entropy, with explanatory notes. 6500 w. Harvard Engng Jour—Jan., 1908. No. 90187 D.

Exhaust Steam.

See Turbines, under STEAM ENGINEERING.

Feed-Water Heaters.

The Use of Heater-Detartarizers. Discusses this class of apparatus for heating feed-water and removing scale-forming ingredients, and the working. 1200 w. Elec Rev, Lond—Jan. 31, 1908. No. 90130 A.

Feed-Water Heating for the Power Plant. Sidney A. Reeve. New suggestions for securing high efficiency and economy of the plant. 1800 w. Engineering Magazine—March, 1908. No. 90574 B.

The Argument for the Open Feed Heater. Reginald Pelham Bolton. A critical discussion of Prof. Reeve's proposals with Prof. Reeve's reply. 900 w. Engineering Magazine—March, 1908. No. 90575 B.

Fuels.

Indirect Gas Heating (Mittelbare Gasheizung). Franz Schäfer. Discusses gas as a boiler fuel for steam and hot-water heating and illustrates types of boiler for small plants. 3500 w. Gesundheits-Ing—Jan. 18 1908. No. 90366 D.

See also Furnaces, under MACHINE WORKS AND FOUNDRIES.

Pistons.

A Rational Method of Checking Conical Pistons for Stress. Prof. George H. Shepard. An explanation of the method, with results of its use in calculating the stress for the conical pistons of the U. S torpedo boat destroyer, Truxtun. 1000 w. Pro Am Soc of Mech Engrs—Feb., 1908. No. 90532.

Piston Speeds.

Limits of Piston Speed. Frederick Strickland. A discussion principally of the limits of excessive wear and tear. 1500 w. Engng—Feb. 7, 1908. No. 90254 A.

Plants.

See Mechanical Plants, and Power Plants, under POWER AND TRANSMISSION; and Central Stations, and Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Smoke Prevention.

Smoke Suppression. Edward J. Kunze. Reviews methods tried for recording smoke observations, describing an instrument and system constructed by the writer. Ills. 2500 w. Engr, Lond—Jan. 31, 1908. No. 90143 A.

How to Burn Illinois Coal Without Smoke. L. P. Breckenridge. Shows that the horizontal fire-tube boiler is not adapted for the smokeless combustion of this coal; discusses how to hand-fire so as to reduce smoke, the preparation of the coal, etc. 3000 w. Boiler Maker—Feb., 1908. No. 89947.

Steam Pipes.

Layout and Installation of Steam-pipe Lines. Warren H. Miller. Discusses

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sizes, materials, erecting, etc. 2500 w. Am Mach—Vol. 31. No. 7. No. 90157.

Steam Receivers.

Use of Low-Pressure Steam from Compound Engines. Illustrates and describes two types of receiver pressure regulators for compound engines. 1000 w. Eng Rec—Feb. 22, 1908. No. 90473.

Superheaters.

Superheater Construction and Operation. J. Rowland Brown. A discussion of types, their location, connections and treatment, with formulae for computing area of heating service. 3500 w. Power—Feb. 25, 1908. No. 90462.

Superheating.

The Specific Heat of Superheated Steam. Prof. Sidney A. Reeve. Gives a comparative study of results obtained by various experimenters. 2500 w. Power—Feb. 18, 1908. Serial. 1st part. No. 90232.

The Regulation of Superheating (Die Regulierung der Dampfüberhitzung). Sigmund Bourdot. Illustrates and describes various methods and devices. 1500 w. Elektrotech u Maschinenbau—Jan. 19, 1908. No. 90370 D.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Turbine Balancing.

The Balancing of Rotors for High Speed. Hans Holzwarth. On the relationship between static and dynamic conditions, and discusses certain methods by which rotors may be dynamically balanced. 1500 w. Power—Feb. 11, 1908. No. 90151.

Turbine Governing.

Governing Steam Turbines. J. A. Moyer. Explanation of the different methods of governing. Ills. 4000 w. Harvard Engng Jour—Jan., 1908. No. 90188 D.

American Turbine Governors with Special Reference to the Lombard and Sturgess Governor (Ueber die amerikanischen Turbinenregulatoren mit besonderer Berücksichtigung des Lombard- und Sturgess Regulators). A. Budau. Illustrated description. 2800 w. Serial. 1st part. Elektrotech u Maschinenbau—Jan. 5, 1908. No. 90369 D.

Turbine Plants.

The Principles Governing the Design of Steam Turbine Plants. Reviews a paper by J. L. Hecht, read before the N.-W. Elec. Assn., explaining features not well understood. 2200 w. Elec Wld—Feb. 15, 1908. No. 90162.

Turbines.

The Manufacture of Small Steam Turbines. K. G. Smith. Illustrates and describes the constructive features. 1000 w. Mach., N Y—Feb., 1908. No. 90059 C.

Turbine Economies. J. R. Bibbins. A criticism of statements by W. L. R. Emmet in a comparison of the efficiency of Curtis and Parsons turbines. 4000 w. St Ry Jour—Feb. 29, 1908. No. 90567.

Some Interesting Features of Steam Turbine and Steam Engineering Construction. Describes one or two reecntly introduced features in the field of the manufacture and operation of the steam turbine and its auxiliaries. 2500 w. Mech Engr—Feb. 7, 1908. Serial. 1st part. No. 90244 A.

The Brush-Parsons Turbine Machinery. Detailed descriptions, with illustrations, of the machines of this company. 3500 w. Engng—Feb. 14, 1908. No. 90495 A.

The Curtis Steam Turbine in Practice. Fred L. Johnson. Explains details of construction, and gives directions for its operation and adjustment. Ills. 1500 w. Power—Feb. 11, 1908. Serial. 1st part. No. 90148.

Tests of a Triple Horizontal Francis Turbine (Versuche an einer dreifachen Horizontal-Francisturbine). E. A. Jacobson. Gives the results of the tests of a 400 horse power turbine in curves and tables. Ills. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 30, 1908. No. 90375 D.

Steam Turbines (Note sur les Turbines à Vapeur). P. Hoffet. The first part of the serial discusses their development, classification, etc., and begins a mathematical examination of the principles of the impulse and reaction types. Ills. 5500 w. Serial. 1st part. Bul Tech d l Suisse Rom—Jan. 10, 1908. No. 90328 D.

The Fundamental and Experimental Theory of Steam and Gas Turbines (Théorie Générique et Expérimentale des Turbines à Vapeur et à Gaz). A. Witz. The first part discusses mathematical principles, the second, the perfections attained by experimental investigations. Ills. 16500 w. Serial. 2 parts. Rev Gen des Sciences—Jan. 15 and 30, 1908. No. 90321, each D.

The Rateau System for the Utilization of Exhaust Steam in the Mining and Smelting Industries (Abdampfverwertung auf Berg- und Hüttenwesen nach Professor Rateau). Herbert Klemperer. Discusses the economies which may be effected by the use of Rateau's low-pressure turbines. 4500 w. Oest Zeitschr f Berg- u Huttenwesen—Jan. 4, 1908. No. 90350 D.

See also Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

TRANSPORTING AND CONVEYING.

Cableways.

Aerial Ropeway at a Colliery. An interesting aërial wire ropeway, recently

erected at the Middleton Colliery, near Leeds, is illustrated and described. 500 w. Engr, Lond—Feb. 14, 1908. No. 90505 A.

Cement Plants.

The Transportation Problem in the Portland Cement Plant. C. J. Tomlinson. Considers the methods in general use and the need of improvements. 2000 w. Eng News—Feb. 13, 1908. No. 90168.

Coal Handling.

An Interesting Coal Handling Plant. Charles M. Ripley. Plans and description of a plant in Pittsburgh. 1400 w. Ir Age—Feb. 13, 1908. No. 90154.

See also Cableways, and Dock Machinery, under TRANSPORTING AND CONVEYING.

Conveyors.

Economical Material-Handling Equipments for Industrial Plants. Werner Boecklin. Illustrates and describes mechanical methods of handling materials; both intermittent and continuous. 5500 w. Engineering Magazine—March, 1908. No. 90577 B.

A Study of Conveyors (Etude sur les Conveyeurs). H. Fischer. A mathematical discussion of their design. The first part being devoted to bucket elevators. Ills. 9000 w. Serial, 1st part. Rev de Mécan—Jan., 1908. No. 90385 E + F.

Flexible Conveyors (Raumbewegliche Förderer). Geor v. Hanffstengel. Illustrates and describes various devices, principally bucket elevators and conveyors, can change their direction of motion as desired. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 25, 1908. No. 90384 D.

See also Cement Plants, under TRANSPORTING AND CONVEYING.

Cranes.

Hoisting Machinery for the Handling of Materials. T. Kennard Thomason. The first of a series of illustrated articles reviewing the mechanical appliances for labor-saving, especially their application to construction. 4500 w. Engineering Magazine—March, 1908. No. 90578 B.

See Dock Machinery, under TRANSPORTING AND CONVEYING.

Dock Machinery.

Hydraulic Plant at the Caledonian Railway Company's New Dock at Grangemouth. Illustrated description of a plant for the operation of dock machinery and crane equipment. 2000 w. Ir & Coal Trds Rev—Jan. 31, 1908. No. 90145 A.

Industrial Railways.

Design and Construction of Automatic Car Systems. Charles J. Steffens. Illustrates and describes the general arrangements of such systems, explaining their economy and advantages. 3000 w. Eng News—Feb. 13, 1908. No. 90164.

Traction Engines.

A Locomotive Sled. Illustrated description of a traction engine used on ice roads, for hauling logs. 700 w. R R Gaz—Feb. 14, 1908. No. 90226.

MISCELLANY.

Aeronautics.

The Problem of Flight. Editorial discussion of what has been accomplished in mechanical flight, and the theories of eminent aeronauts. 2000 w. Engng—Feb. 14, 1908. No. 90498 A.

Aerial Navigation. Herbert Chatley. Abstract of a paper read before the Jr. Inst. of Engrs. Deals particularly with the aeroplane. 1800 w. Auto Jour—Feb. 15, 1908. Serial. 1st part. No. 90481 A.

Air Resistance.

M. Eiffel's Investigations on the Resistance of the Air (Les Expériences de M. Eiffel sur la Résistance de l'Air). The methods and results of extensive experiments carried out at the Eiffel tower in Paris. 1700 w. Rev de Mécan—Dec., 1907. No. 90317 E + F.

Etching.

The Rubber Stamp Method of Etching Metals and Its Use in the Manufacture of Steel Knives. Brief review of the history and explanation of the principle of this method, with illustrated description of the operations. 3300 w. Brass Wld—Feb., 1908. No. 90549.

Marble Working.

New Machinery for the Application of Abrasives to Marble Working. J. Royden Peirce. Illustrates and describes the general outlines of a new process which produces work superior to any before obtained. 1500 w. Eng News—Feb. 6 1908. No. 90084.

Paper Making.

Developments in the Paper and Pulp Industry. Reviews the more important features of a recent paper by Arthur D. Little. Especially discusses sources of paper stock. 2000 w. Eng Rec—Feb. 22, 1908. No. 90472.

Machinery and Power Required for the Production of Paper Pulp, Mechanical and Chemical, and Finished Paper. John W. Thurso. Gives information necessary to make an estimate of the necessary machinery, including engine and boiler equipment. 1500 w. Eng News—Feb. 20, 1908. No. 90410.

See also Electric Driving, under POWER AND TRANSMISSION.

Printing Machinery.

Money and Money-Making Machinery. Claude E. Holgate. An interesting illustrated description of the work of the Bureau of Engraving and Printing, at Washington, D. C., the machines used, etc. 3500 w. Mach, N Y—Feb., 1908. No. 90057 C.

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MINING AND METALLURGY

COAL AND COKE.

Anthracite.

Centralized Consumption of Anthracite Coal. Howard McNayr Jefferson. Reviews, in the present article, the development of the anthracite industry. 5500 w. Jour of Accountancy—Jan., 1908. Serial. 1st part. No. 90177 C.

Australia.

The Brown Coal Deposits of Victoria. Reginald A. F. Murray. Brief description of the deposits, the localities of occurrence, etc. 1500 w. Aust Min Stand—Jan. 8, 1908. Serial. 1st part. No. 90293 B.

Briquetting.

The Briquetting of Coal (Die Brikettierung der Steinkohlen). F. Bock. Describes machines and processes and discusses the extent of the industry in Europe. Ills. 3500 w. Glückauf—Jan. 4, 1908. No. 90352 D.

Cape Breton.

General Description of the Sydney Coal Field. Map and illustrated description of mining operations in Cape Breton, N. S. 1500 w. Can Min Jour—Feb. 15, 1908. No. 90294.

Coking By-Products.

The Present Status of the By-Product Coke Oven in the United States. C. G. Atwater. Information in regard to the amount of coke and various by-products produced. 4000 w. Mines & Min—Feb., 1908. No. 90032 C.

Coking Plants.

A Recent Plant for the Utilization of Small Coal. E. M. Hann. Plans and description of the by-product plant recently erected at the Bargoed Colliery, South Wales. 5000 w. Col Guard—Jan. 31, 1908. No. 90134 A.

Electric Power.

Gas-Tight Switches. W. Bolton Shaw. The importance of these switches in mining work, and the principles of their design. 2000 w. Elec Rev, Lond—Jan. 31, 1908. No. 90129 A.

Explosions.

Coal-Mine Explosions, Their Cause and Prevention. Lawrence Brett. Discusses the special conditions that exist in the mines of Kansas. 4500 w. Mines & Min—Feb., 1908. No. 90036 C.

The Prevention of Coal Mine Explosions. Carl Schulz and R. S. Mors. Considers the causes and discusses preventives and precautions necessary. 2000 w. Min Wld—Feb. 8, 1908. No. 90115.

Equipment for the Prevention of Mine Explosions. Wilbur S. Mavers. Discusses this problem and suggests methods of freeing mines from dust. 2000 w. Eng & Min Jour—Feb. 22, 1908. No. 90460.

Monongah Disaster. Official reports, with verdict of the Coroner's jury. 7000 w. Mines & Min—Feb., 1908. No. 90033 C.

Report on the Monongah Mine Explosion. George Harrison. 2000 w. Eng & Min Jour—Feb. 1, 1908. No. 89972.

Yolande Mine Disaster. Official report to the Governor of the State of Alabama. 2000 w. Mines & Min—Feb., 1908. No. 90034 C.

Results of Inquiries into Recent Mine Disasters. Floyd W. Parsons. Illustrations of the Monongah disaster, with discussion of causes, though no definite conclusions have been reached. Dust has been a factor in explosions. 2500 w. Eng & Min Jour—Feb. 1, 1908. No. 89971.

Fuse.

See same title, under MINING.

Mining.

Science in Mining. Henry Briggs. Inaugural address delivered on the opening of the new Department of Mining in the Heriot-Watt College, Edinburgh. 4400 w. Ir & Coal Trds Rev—Jan. 24, 1908. No. 90021 A.

Coal Mining by the Bord-and-Pillar System. George Raylton Dixon. Illustrated description of methods. 2400 w. Eng & Min Jour—Feb. 22, 1908. No. 90461.

Mining Plants.

The Plant of the de Wendel Colliery, Herringen (Die Anlagen des Steinkohlenbergwerks de Wendel in Herringen bei Hamm i. W.). A. Hochstratl. Illustrated detailed description. 2100 w. Serial. 1st part. Glückauf—Jan. 11, 1908 No. 90354 D.

North America.

Coal and Iron in North America (Kohle und Eisen in Nordamerika). Prof. Baum. A Comparison of conditions in Canada and the United States with those of Germany. Ills. 4000 w. Serial. 1st part. Glückauf—Jan. 4, 1908. No. 90351 D.

Production.

An Interesting Article on Coal Production for the Year 1907. A review of the operations throughout the United States, prepared by the U. S. Geol. Survey. 8000 w. Ind Wld—Feb. 17, 1908. No. 90214.

Rescue Appliances.

Breathing Apparatus for Use in Mines. Leonard Hill. Lecture at the N. Staffordshire Inst. of Min. & Mech. Engrs. Some

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considerations of the physiological effects of foul air, and the principles of construction of breathing apparatus. 4500 w. Engng—Jan. 17, 1908. No. 90049 A.

The Rescue Methods of the Laurahütte Colliery in the Nord-Kaltowitz District (Das Rettungswesen auf dem Steinkohlenbergwerke Laurahütte im Bergrevier Nord-Kaltowitz). Herr Backwinkel. Describes the central rescue station, its equipment, training methods, etc. Ills. 2000 w. Glückauf—Jan. 11, 1908. No. 90355 D.

Tipples.

See same title, under MINING.

COPPER.

Alaska.

See same title, under GOLD AND SILVER.

Assaying.

Sodium Peroxide in the Chemical Laboratory. Herbert W. Ross and N. M. Zoph. Outlines methods in satisfactory use in the laboratory of the Union Copper Mining Co., California. 900 w. Min & Sci Pr—Feb. 22, 1908. No. 90558.

British Columbia.

The Boundary District in 1907. Progress and results at mines and smelters. Ills. 6500 w. B C Min Rec—Dec., 1907. No. 90560 B.

Mining in the Kootenay Districts in 1907. A review of the year's operations and results in these copper and silver-lead fields. Ills. 5500 w. B C Min Rec—Dec., 1907. No. 90559 B.

Lake Superior.

See Copper, under ORE DRESSING AND CONCENTRATION.

Matte Handling.

Method of Handling Matte at Selby, California. James C. Bennett. The material is tapped into shallow pans of steel carried upon all-iron trucks, moved by means of long-hook bars. Ills. 700 w. Eng & Min Jour—Feb. 1, 1908. No. 89969.

Production.

The Future of Copper and the Scarcity of Gold. J. J. Cushing. Gives comparative statistics of the two metals. 2000 w. Min Sci—Feb. 6, 1908. Serial. 1st part. No. 90114.

Smelters.

The Douglas Copper Smelter at Fundicion, Mex. Percy E. Barbour. Illustrated description of a one-level blast-furnace plant having novel features of interest. 2000 w. Eng & Min Jour—Feb. 8, 1908. No. 90103.

Utah's Largest Copper Smelter. Robert B. Brinsmade. Illustrated description of the Garfield plant of the American Smelting and Refining Co., Garfield, Utah. 6500 w. Mines & Min—Feb., 1908. No. 90030 C.

Smelting.

See Matte Handling, under COPPER.

Yukon.

The White Horse Copper Belt in the Yukon. William J. Elmendorf. Begins an illustrated description of the region, the climate, conditions, development, etc. 1100 w. Min Wld—Jan. 11, 1908. Serial. 1st part. No. 89978.

GOLD AND SILVER.

Alaska.

Mining in the Wrangell District, Alaska. An account of the development of the gold placers and the copper projects. 2500 w. Min & Sci Pr—Feb. 8, 1908. No. 90218.

Australia.

The Deep Leads of Victoria, Australia. Quotes statements from the recent paper of H. L. Wilkinson, showing where they need to be amended or amplified to give a correct understanding. Also added information. 2500 w. Min Jour—Jan. 25, 1908. No. 90014 A.

See also Gold Milling, under ORE DRESSING AND CONCENTRATION.

Brazil.

See Palladium, under MINOR MINERALS.

Cyaniding.

Notes on Cyanide Treatment of Gold Ores. G. E. Bray. Read before the N. Queensland Min. & Mill Mgrs. Assn. Gives details of the scope and costs of the cyanide treatment in various places. 3000 w. Min Jour—Feb. 15, 1908. Serial. 1st part. No. 90492 A.

Cyanidation in Nevada. A letter from Lochiel M. King, giving data of recent tests on ores furnished by the Goldfield Con. Mines Co., outlining the method of treatment that seems most economical to the writer. 3300 w. Min & Sci Pr—Jan. 25, 1908. No. 89933.

See also Gold Milling, under ORE DRESSING AND CONCENTRATION.

New Zealand.

Gold-Mining in Central Otago. Abstracts from Bul. No. 2 (new series) of the New Zealand Geol. Survey. Historical and descriptive. 4000 w. N Z Mines Rec—Dec. 16, 1907. Serial. 1st part. No. 90291 B.

Gold-Mining at Coromandel. Extracts from Bul. No. 4 (new series) of the N. Z. Geol. Survey. Description, with report of development. 3500 w. N Z Mines Rec—Dec. 16, 1907. Serial. 1st part. No. 90292 B.

Placers.

See Alaska, under GOLD AND SILVER.

Production.

See same title, under COPPER.

Smelting.

An Improvement in Tipping Pots Dur-

ing Smelting. W. D'Arcy Lloyd. Diagram and description of a device for pouring quickly and easily. 500 w. Jour Chem, Met, & Min Soc of S Africa—Dec., 1907. No. 90237 E.

South Africa.

The Auriferous Banded Ironstones and Associated Schists of South Africa. Owen Letcher. Describes these formations, which are the oldest known auriferous sedimentary rocks in South Africa. 4500 w. Inst of Min & Met, Bul No. 40—Jan. 9, 1908. No. 90547 N.

Consolidated Gold Fields of South Africa, Ltd. Eustace M. Weston. Notes on the last report of this company. Ills. 1000 w. Eng & Min Jour—Feb. 15, 1908. No. 90210.

IRON AND STEEL.

Blast Furnaces.

A Breakout in a Blast-Furnace of the Societa Elba at Portoferraio. Remo Catani. A contribution to the study of accidents in blast furnace practice. 2200 w. Ir & Coal Trds Rev—Feb. 7, 1908. No. 90267 A.

Blast-Furnace Slag.

See Concrete Brick, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Blowing Engines.

A Large Gas Blowing-Engine. Illustration and description of a new Premier engine. 500 w. Engr, Lond—Feb. 7, 1908. No. 90264 A.

Modern Gas Blowing Engines of Unique Design. Frank C. Perkins. Illustrated description of engines operating on blast-furnace gas used in steel mills in Europe and America. 2500 w. Engr, U S A—Feb. 1, 1908. No. 89995 C.

Practical Notes on the Construction and Operation of Gas Blowing Engines (Erfahrungen in Bau und Betriebe von Gasgebläsen). Herbert Baer. A general discussion. Ills. 4000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—Jan. 4, 1908. No. 90378 D.

See also Turbo-Compressors, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

China.

The Iron Industry in China (Aus der chinesischen Eisenindustrie). C. Blauel. Mainly devoted to a description of the Hanyang Iron and Steel Works. Ills. 3500 w. Stahl u Eisen—Jan. 1, 1908. No. 90342 D.

The Chinese Iron and Steel Industry. C. Blauel. Trans. from *Stahl und Eisen*. An illustrated article giving interesting information concerning the Hanyang works. 2000 w. Elec. Chem & Met Ind—Feb., 1908. No. 90027 C.

Chromite.

See same title, under MINOR MINERALS.

Electro-Metallurgy.

A New Electric Furnace for the Fusion of Steel (Nouveau Système de Four Electrique pour la Fusion de l'Acier). B. Igewsky. Describes the author's high-tension furnace. Ills. 2500 w. Rev de Métal—Jan., 1908. No. 90316 E + F.

The Electric Production of Iron (Ueber elektrische Eisendarstellung). Josef von Ehrenwerth. Discusses the progress of the electro-metallurgy of iron, products of the electric furnace, types of furnaces and processes, etc. Ills. 1600 w. Oest Zeitschr f Berg- u Hüttenwesen—Jan. 4, 1908. No. 90349 D.

Ferro-Alloys.

The Manufacture and Use of Ferro-Alloys. Brief account of the best methods of manufacturing these alloys, with descriptions of the more important works in Europe and America. Ills. 2700 w. Engr, Lond—Jan. 24, 1908. Serial. 1st part. No. 90019 A.

Ferro-Alloys and Metals for the Steel Industry (Ueber Eisenlegierungen und Metalle für die Stahlindustrie). Wilhelm Venator. An extensive discussion of their production, properties, use, etc. 6000 w. Serial. 1st part. Stahl u Eisen—Jan. 8, 1908. No. 90344 D.

Special Alloys for the Steel Industry. W. Venator, in *Stahl und Eisen*. A review of the particulars relating to the raw materials, production, composition, properties, application, price and commercial uses of these substances. 5000 w. Ir & Coal Trds Rev—Feb. 7, 1908. No. 90266 A.

New Jersey.

The Last of the Jersey Forges. Edward P. Buffet. An illustrated account of the old forges of New Jersey, and their methods. 1200 w. Eng & Min Jour—Feb. 8, 1908. No. 90105.

New York.

The Economic Geology of Northern New York. Frank S. Mills. Describes this region which contains deposits of pyrites, graphite, and iron ores. Ills. 1600 w. Eng & Min Jour—Feb. 22, 1908. No. 90457.

North America.

See same title, under COAL AND COKE.

Open Hearth.

New Open-Hearth Plant of Messrs. Monks, Hall & Company. Short illustrated description of works at Warrington, Eng. 1500 w. Ir & Coal Trds Rev—Feb. 7, 1908. No. 90268 A.

Rails.

See same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Rolling Mills.

The Driving of Modern Rolling Mills. G. Hoaghwinkel. Abstract of a paper before the Sheffield Soc. of Engrs. & Met. Discusses the driving of three-high mills of the heaviest type by steam engines, by gas engines, and by electric motors, giving particulars of cost. General discussion. 3000 w. Elect'n,—Lond—Feb. 14, 1908. No. 90489 A.

See also Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Steel Ingots.

The Compression of Semi-Liquid Steel Ingots. N. Lilienberg. Discusses practical manipulation for the improvement of steel. Reviews other methods and describes a patented system of compression. Ills. 7000 w. Jour Fr Inst—Feb., 1908. No. 90433 D.

Steel Works.

The Andrews Steel Company's Plant. Illustrated description of a plant at Newport, Ky., specially equipped for rolling sheet bars and billets. 1000 w. Ir Age—Feb. 20, 1908. No. 90296.

The Krupp Works at Rheinhausen. Illustrated description of the blast furnaces, coke ovens, Bessemer and open hearth steel works, blowing and finishing mills. 3500 w. Ir Age—Feb. 27, 1908. No. 90526.

The Friedrich-Alfred Steel Works at Rheinhausen (Die Friedrich-Alfred Hütte zu Rheinhausen). H. Groeck. An illustrated description of this Krupp plant. 2200 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1908. No. 90383 D.

See also China, and Open Hearth, under IRON AND STEEL.

Storage.

See Warehouses, under CIVIL ENGINEERING, CONSTRUCTION.

Tin Plate.

Tin Plate Making at Follansbee, W. Va. Illustrated description of new works, the methods and processes used. 3500 w. Met Work—Feb. 15, 1908. No. 90191.

Trade.

Conditions and Prospects in the American Iron Industry. Edwin C. Eckel. A review of the financial history and of the trade in 1907, the effect of the recent panic, etc. 4000 w. Engineering Magazine—March, 1908. No. 90570 B.

LEAD AND ZINC.

Associated Minerals.

See Gangue, and Joplin District, under LEAD AND ZINC.

British Columbia.

See same title, under COPPER.

Colorado.

The Montezuma Mining District, Colorado. Etienne A. Ritter. An illustrated account of the revival of a lead-silver-zinc camp on an extension of the Georgetown and Silver Plume belt. 1800 w. Eng & Min Jour—Feb. 1, 1908. No. 89967.

England.

The Greenside Lead Mines, Cumberland. E. Thomas Borlase. An illustrated account of mining and milling methods in English mines which have been opened over 200 years. 3000 w. Eng & Min Jour—Feb. 8, 1908. No. 90102.

Gangue.

Gangue and Associated Minerals of Lead and Zinc. Otto Ruhl. On the recovery and utilization of fluorspar, barite, marcasite, pyrite, chalcopyrite, and the important bearing of these minerals on genesis of ores. 1800 w. Min Sci—Jan. 30, 1908. No. 89981.

Joplin District.

The Minerals of Joplin and Their Association. Doss Brittain. Some account of the minerals, of which there are over twenty. Ills. Min Wld—Feb. 15, 1908. No. 90217.

MINOR MINERALS.

Cement.

The New Mill of the Union Portland Cement Co. A mill with a rated capacity of 2,500 barrels a day, located in northeastern Utah, is illustrated and described. 4000 w. Eng Rec—Feb. 1, 1908. No. 89960.

Chromite.

Chrome Iron Mining in Canada. H. F. Strangways. First of a series of articles on the mining industries of Quebec. Outlines the history of this industry in Quebec, describing the geology, methods of mining, concentration, etc. Discussion. 6000 w. Can Soc of Civ Engrs, Bul. No. 2—Dec., 1907. No. 90544 N.

Diamonds.

The Formation and Manufacture of Diamonds. Editorial review of what is now known in regard to the origin of diamonds. 1700 w. Min Jour—Feb. 15, 1908. No. 90493 A.

Geology and Mining in Arkansas Diamond Field. Philip F. Schneider. Extract from the preliminary report to the Bureau of Mines of Arkansas. Describes the field, the gems, and discusses the value. 3500 w. Min Wld—Feb. 8, 1908. No. 90116.

The Eruptive Diamond-Bearing Breccias of the Boshof District, S. Africa. J. P. Johnson. Describes the gem-bearing rocks. 3000 w. Inst of Min & Met, Bul. No. 40—Jan. 9, 1908. No. 90546 N.

The Vaal River Diamond Diggings. Mungo Park. Describes these deposits in Africa, the methods of working, etc. 1800 w. Inst of Min & Met, Bul. No. 40—Jan. 9, 1908. No. 90545 N.

We supply copies of these articles. See page 158.

Graphite.

Some Characteristics of Natural Graphite. Frederic S. Hyde. Describes the physical and chemical properties and the characteristics of various graphites. 2000 w. Eng & Min Jour—Feb. 1, 1908. No. 89970.

Canadian Graphite. H. Mortimer Lamb. Information concerning the deposits and their development, as reported in a monograph issued by the Canadian Dept. of Mines. 2500 w. Eng & Min Jour—Feb. 15, 1908. No. 90211.

See also New York, under IRON AND STEEL.

Limestone.

The Composition of Limestones (Sur la Constitution Intime des Calcaires). E. Leduc. A record of extensive investigations on the physical and chemical qualities of limestones with regard to their use for the production of lime. Also tests of mortar, cement, etc. Ills. 30000 w. Bul du Lab d'Essais—No. 10, 1907. No. 90306 N.

Monazite.

See Tungsten, under MINOR MINERALS.

Oil.

Oil Industry of the United States. Reviews the part of the third Government Report on the Standard Oil Company that refers to prices and profits. 2500 w. Min & Sci Pr—Feb. 8, 1908. No. 90219.

Palladium.

The Occurrence of Palladium in Brazil. Dr. E. Hussak. Describes the occurrences in different mines, of forms of palladic gold. 3000 w. Min Jour—Feb. 1, 1908. No. 90133 A.

Platinum.

The Occurrence of Palladium in Brazil. Dr. E. Hussak. Describes the deposits at various places. 2500 w. Min Jour—Feb. 15, 1908. No. 90491 A.

Salt.

An Improved Method for Mining Salt. Herman Frasch. An invention is illustrated and described relating to the recovery of any saline substance soluble in water from a natural deposit. 1800 w. Min Wld—Feb. 15, 1908. No. 90215.

Tin.

Notes on Tin Mining in Cape Colony. Harry D. Griffiths. A descriptive account of the deposits and methods of mining and working. Ills. 8800 w. Jour Chem, Met, & Min Soc—Dec., 1907. No. 90238 E.

Tungsten.

Occurrence, Character and Uses of Some Rare Metals. H. P. Dickinson. The properties, determination and preparation as commercial products of tungsten and uranium; and the value of monozite in the manufacture of gas mantles. 2000 w. Min Sci— Jan. 30, 1908. No. 89983.

Uranium.

See Tungsten, under MINOR MINERALS.

MINING.

Accidents.

See Rescue Work, under MINING.

Claim Location.

The Location and Survey of Lode Mining Claims. Frank B. Gaudy. The first of a series of articles intended to aid in locating, surveying and patenting mining claims. The present article treats mineral land acquisitions, apex rights, location methods, etc. 1800 w. Min Sci—Feb. 20, 1908. Serial. 1st part. No. 90453.

Drilling.

Methods and Equipment for Prospecting Placers. H. C. Ludlum. Illustrated description of investigating and prospecting methods to determine the value of land for dredge mining. 4000 w. Min Wld—Feb. 1, 1908. No. 89979.

See also Excavation, under CIVIL ENGINEERING, CONSTRUCTION.

Drills.

A Hand Power Rock Drill. L. B. Orchard. Illustrated description of the Evans hand power rock drill, showing the advantages of its use. 900 w. Can Min Jour—Feb. 15, 1908. No. 90295.

Drills for Stoping. Algernon Del Mar. Explains the advantages of the small air-hammer stoping drill. 1400 w. Min & Sci Pr—Feb. 1, 1908. No. 90074.

Trial of Stoping Drills. An account of a most interesting test at Johannesburg, when the "Gordon drill" was declared the winner under the test conditions. Ills. 4000 w. Engr, Lond—Feb. 7, 1908. No. 90262 A.

The Merits and Demerits of Air-Hammer Drills. G. E. Wolcott. Discusses the different forms of bits and shank used, types, and related matters. Ills. 2000 w. Eng & Min Jour—Feb. 15, 1908. No. 90209.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Hoisting.

Electrical Winding Plant at the Axwell Park Colliery. Illustrated detailed description of an installation of the Ilgner system. 2000 w. Col Guard—Feb. 7, 1908. No. 90253 A.

See also Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Explosives.

The Composition and Properties of Mining Explosives. W. H. Graves. On the characteristics and uses of the deflagrating and detonating varieties. 1000 w. Min Sci—Feb. 6, 1908. No. 90112.

We supply copies of these articles. See page 158.

Composition, Classification and Uses of High Explosives. W. H. Graves. Considers explosive compounds and mixtures; especially nitro-glycerin, dynamites, gun-cotton, Sprengel, and safety explosives. 2000 w. Min Sci—Feb. 20, 1908. No. 90452.

Fuse.

New Fuse for Increasing the Safety of Shot-Firing in Fiery Mines. M. Lheure, in *Annales des Mines*. Aims to prevent miss-fires by igniting the blasting charge along its whole length, by means of a leaden detonating tube charged with trinitrotoluene. 1200 w. Col Guard—Jan. 24, 1908. No. 90015 A.

Haulage.

See Tipples, under MINING.

Hoisting.

Winding-Ropes, Safety-Catches, and Appliances in Mine-Shafts. A discussion of recent improvements in mechanical appliances for increasing the safety of mine workers. Ills. 3000 w. Engng—Feb. 14, 1908. Serial. 1st part. No. 90494 A.

Hoisting Engines.

3,000-Horse-Power Winding-Engine. Illustrated description of a pair of winding-engines recently installed at Nine-Mile Point Colliery, South Wales. 1200 w. Engng—Jan. 17, 1908. No. 90044 A.

Law.

See Claim Location, under MINING.

Management.

Functions of the Consulting Mining Engineer. Allen Hastings Rogers. Small companies are advised to employ them as non-resident managers. 2000 w. Eng & Min Jour—Feb. 8, 1908. No. 90106.

Plants.

See Mining Plants, under COAL AND COKE.

Prospecting.

Practical Prospecting in the Missouri-Kansas District. Otto Ruhl. Suggestions for careful and thorough work. Ills. 2200 w. Min Wld—Feb. 22 1908. No. 90451.

Rescue Work.

Rescuing the Men Entombed at Alpha Shaft, Near Ely, Nevada. E. W. Walter. Describes methods of sustaining and finally rescuing men imprisoned 46 days. 1700 w. Eng & Min Jour—Feb. 22, 1908. No. 90459.

Shafts.

Puddling a Wet Shaft. Henry Boursin. An account of puddling a wet shaft in a drift-gravel mine in British Columbia. Ills. 1200 w. Min & Sci Pr—Jan. 25, 1908. No. 89934.

Shaft Sinking.

Sinking a Five-Compartment Shaft on the Rand. Eustace M. Weston. Gives details of the methods employed, and an account of difficulties caused by breakage of drill steel in hard rock. Ills. 4000 w. Eng & Min Jour—Feb. 22, 1908. No. 90456.

Stoping.

See Drills, under MINING.

Surveying.

An Investigation of the Errors Occurring in the Orientation of an Underground Survey. T. Ernest Robertson. A mathematical investigation of the orientation effected by means of plumb lines suspended in vertical shafts. 2000 w. Jour S African Assn of Engrs—Dec., 1907. No. 90233 F.

See also Claim Location, under MINING.

Tipples.

A Handling and Dumping System for Mine Cars. O. V. Greene. Illustrated description of a method of combining the car haul and dumping apparatus. 4000 w. Mines & Min—Feb., 1908. No. 90035 C.

Chains and Cross-bars for Handling Mine Cars. O. V. Greene. Illustrated detailed description of a car-haul conveyor. 2500 w. Eng & Min Jour—Feb. 8, 1908. No. 90107.

Ventilation.

The Conditions Influencing Mine Ventilation. Jos. H. Hart. A discussion of modern methods and agencies found helpful. 3500 w. Min Wld—Feb. 15, 1908. No. 90216.

Note on the Daily Variation of Rand Mine Ventilation. James Moir. Gives experimental results of the variation from night to day, and on rainy and rainless days, with explanation of methods used to counteract its effects. 1200 w. Jour Chem, Met, & Min Soc of S Africa—Nov., 1907. No. 90234 E.

The Influence of Natural Currents of Air on the Mechanical Efficiency of Fans (Der Einfluss des natürlichen Wetterstromes auf den mechanischen Wirkungsgrad der Ventilatoren). Herr Kegel. A discussion both theoretical and practical. Ills. 4000 w. Glückauf—Jan. 25, 1908. No. 90356 D.

Wages.

The Incidence of Methods of Payments on the Efficiency of Miners. Kenneth Austin. Gives a summary of some of the advantages and disadvantages of the various systems. 1500 w. Jour Chem, Met, & Min Soc of S Africa—Nov., 1907. No. 90235 E.

ORE DRESSING AND CONCENTRATION.

Black Sands.

Black Sands. Arthur R. Townsend. Discusses their treatment, offering suggestions. 2000 w. Eng & Min Jour—Feb. 8, 1908. No. 90104.

We supply copies of these articles. See page 158.

Copper.

Lake Superior Ore-Dressing Practice. L. S. Austin. Illustrates and describes present practice in this copper region. 800 w. Min & Sci Pr—Feb. 22, 1908. No. 90556.

Experimental Plant.

Ore Testing at Salt Lake. Ernest Gayford. Illustrated description of the plant of the General Engineering Co. and its methods. 1200 w. Min & Sci Pr—Jan. 25, 1908. No. 89936.

Gold Milling.

Metallurgy of the Kalgoorlie Goldfield. Gerard W. Williams. The complex ores are roasted either before or after concentration, and fine-grinding is necessary for extraction by cyanide. Illustrates and describes methods. 5500 w. Eng & Min Jour—Feb. 15, 1908. No. 90208.

Treatment Problem of the Republic (Wash.) Gold Ores. Fritz Cirkel. Reviews the history of the treatment of this ore, much money having been spent in research, but the problem not satisfactorily solved. 2200 w. Eng & Min Jour—Feb. 1, 1908. No. 89968.

See also Slimes Treatment, under ORE DRESSING AND CONCENTRATION.

Lead Milling.

Milling on the Coeur d'Alene. George Huston. A criticism of the practice. 1000 w. Min & Sci Pr—Feb. 15, 1908. No. 90455.

See also England, under LEAD AND ZINC.

Slimes Treatment.

Advances in Slime Concentration Practice. Edwin A. Sperry. Considers crushing, regrinding, classification and sizing, dewatering and final treatment. 2500 w. Min Sci—Jan. 30, 1908. Serial. 1st part. No. 89980.

The Treatment of Slimes in the Black Hills. S. E. Bennett. Illustrates and describes the methods in use at the Homestake plant. 1000 w. Min Wld—Feb. 22, 1908. No. 90450.

MISCELLANY.

Ore Deposits.

A Theory of Ore-Deposition. J. E. Spurr. A theory based on magmatic differentiation is explained. 4500 w. Min & Sci Pr—Feb. 22, 1908. No. 90557.

Diffusion as a Factor in Ore Deposition. Courtenay De Kalb. Explains how osmotic pressure facilitates concentration, and the effect of other forces. 1500 w. Min & Sci Pr—Feb. 15, 1908. No. 90454.

Some Interesting Experiences with Ore-Bearing Veins. Arthur Lakes. Discusses the occurrence and peculiarities of lenticular plication veins in Idaho, and the methods and profits of their mining. 1000 w. Min Sci—Jan. 30, 1908. No. 89982.

Panama.

Mining in Panama. Scott Turner. An account of the conditions prevailing and the past and present mining prospects, showing the field to be unattractive. Ills. 2500 w. Min & Sci Pr—Jan. 25, 1908. No. 89935.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Four Railway Accidents. Particulars of recent accidents reported by the British Board of Trade. 3000 w. Engr, Lond—Feb. 14, 1908. No. 90503 A.

Accident Bulletin No. 25. Information from bulletin issued by the Interstate Commerce Commission. 3500 w. R R Gaz—Feb. 7, 1908. No. 90079.

What Are We Going to Do About Railroad Accidents? W. H. Boardman. An open letter to newspaper editors discussing the many accidents in the United States, and the possible remedies. 3000 w. R R Gaz—Jan. 31, 1908. No. 89940.

Problems.

Some Joint Problems of the Mechanical and Operating Departments of a Railroad. Dexter C. Buell. Discusses power and equipment, tonnage, handling of materials, etc., showing the value of co-operation. General discussion. 8000 w. Pro Cent Ry Club—Jan. 10, 1908. No. 90551 C.

Signalling.

A System of Audible Signalling on Railways. W. Dawson. Paper and discussion before the Engng. Conference, 1907. 5800 w. Bul Int Ry Cong—Jan., 1908. No. 90286 E.

Switching.

The Application of the Bleynie et Ducousso Collective System to the Distant Electrical Working of Points in the Gravity Yard at Bordeaux-Saint-Jean Station (Application des Leviers d'Itinéraires—Système Bleynie et Ducousso—à la Commande Electrique à Distance des Aiguilles d'un Faisceau de Triage par la Gravité dans la Gare de Bordeaux-Saint-Jean). Ch. Gufflet. Ills. 11000 w. Rev Gen de Chem de Fer—Jan., 1908. No. 90319 G.

Trains.

The Continental Limited. Illustrated description of a fast train on the Boston & Maine R. R., and the interesting fea-

tures of the route. 500 w. Ry & Loc Engng—Feb., 1908. No. 89984 C.

Train Service.

The Express Business. C. H. Crosby. From an address before the Traffic Club of New York. Brief review of the development, improvements, and changes. 1700 w. R R Gaz—Feb. 14, 1908. No. 90228.

Express Train Services of 1907.—British and French. Charles Rous-Marten. Comparative statistics relating to speed are given. 1500 w. Engr, Lond—Feb. 7, 1908. No. 90261 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Cleaning Locomotive Triple Valves. Directions for cleaning when there is not time to remove the triple valve. 1300 w. Ry & Loc Engng—Feb., 1908. No. 89988 C.

The Siemens Brake for Fast Trains. Illustrated description of an attempt to proportion the brake pressure to the coefficient of friction, which varies with the speed. 2300 w. Bul Int Ry Cong—Jan., 1908. No. 90281 E.

Freight Train Breaking Tests on the Hungarian State Railway, carried out on the Level Track between Pozsony and Ersekujvár (Güterzug-Bremsversuche der Kgl. Ungarischen Staatsbahn auf der Flachbahnstrecke Pozsony-Ersekujvár). Gives in curves and tables the results of extensive tests on Westinghouse brakes. Ills. 7500 w. Glasers Ann—Jan. 1, 1908. No. 90359 D.

Car Building.

See Shops, under MOTIVE POWER AND EQUIPMENT.

Cars.

Indian Broad-Gauge Railways. H. Kelway Bamber. Sketches and description of third-class coaching stock. 1000 w. Engng—Jan. 17, 1908. No. 90043 A.

The Era of Steel and the Passing of Wood in Car Construction. Arthur M. Waitt. Considers the progress and changes in the construction of railway cars especially in the United States and Canada. Also discussion. 16500 w. Pro N Y R R Club—Jan. 17, 1908. No. 90185.

Car Ventilation.

The Garland Car Ventilator. Illustrated description of this device and its principles of operation. 1200 w. Ry & Engng Rev—Feb. 22, 1908. No. 90441.

Couplers.

The Exhibits of Automatic Couplers for Railway Cars at the Milan Exposition, 1906 (Il Concorso per uno Studio di Sistema Automatico di Agganciamento di Vagoni Ferroviari bandito in Occasione dell' Esposizione Internazionale di Milano, 1906). A. Campiglio. The first part describes the Pavia-Casalis coupler. Ills. 2500 w. Serial, 1st part. Monit Tech—Jan. 10, 1908. No. 90339 D.

Draft Gears.

The Draft Gear. A. Stucki. Discusses the momentum taken by the draft gear, the principle of different gears, construction, repairs, etc. Ills. General discussion. 13000 w. Pro Ry Club of Pittsburgh—Dec., 1907. No. 90530 C.

Dynamometer Cars.

Dynamometer Cars (Les Wagons Dynamométriques). A. Rodrigue. Describes the cars of the French railways and the more important types in use in other countries. Ills. 10000 w. Mem Soc Ing Civ de France—Nov., 1907. No. 90305 G.

Electrification.

Electrification of Railways. Dr. Gisbert Kapp. Lecture delivered before the Roy Inst. of Gt. Britain. Presents the advantages of electrification, and the improvements looked for in this work. Ills. 2300 w. Elec Engr, Lond—Jan. 24, 1908. Serial, 1st part. No. 90006 A.

Some Reflections on Railway Electrification. Philip Dawson. Explaining the advantages of the single-phase system, and discussing the causes which lead to the electrification of railways. 2500 w. Elec Rev, Lond—Feb. 14, 1908. No. 90487 A.

The Electrification of the Suburban Zone of the New York Central and Hudson River Railroad in the Vicinity of New York City. William J. Wilgus. A full paper explaining the reasons for the change from steam to electricity, describing the general features of construction and operation, and the results. Map and Ills. 10800 w. Pro Am Soc of Civ Engrs—Feb., 1908. No. 90553 E.

Feed-Water Heating.

Locomotive Feed Water Heater. Illustrated description of the F. F. Gaines heater, being tried on the Central of Georgia Railway. 900 w. Am Engr & R R Jour—Feb., 1908. No. 89992 C.

Gasoline Locomotive.

The Vanguard Gasoline Locomotive. Illustration, with brief description of a light locomotive for switching, etc. 700 w. Ir Age—Feb. 13, 1908. No. 90153.

Locomotive Design.

Some Notes on Current Locomotive Practice. Discusses present practice and the demand for power and economy. 1200 w. Prac Engr—Feb. 7, 1908. Serial, 1st part. No. 90243 A.

Locomotive Management.

Economical Locomotive Handling. Address by W. H. Bradley, at the Railroad Y. M. C. A., at Boone, Ia., on how to take advantage of, and handle a locomotive economically. 1500 w. Ry & Loc Engng—Feb., 1908. No. 89990 C.

We supply copies of these articles. See page 158.

Locomotive Oscillation.

Is the Endway Oscillation of Locomotives a Disturbing Movement? Mr. Strahl. Trans. from *Ann. für Gewerbe und Bauwesen.* Defending the utility of tests made on a testing plant. 6200 w. Bul Int Ry Cong—Jan., 1908. No. 90288 E.

Locomotives.

Engines for the Nickel Plate. Illustrates types of engines for passenger, and for freight service, recently built for the N. Y., C. & St. L. Ry. 1200 w. Ry & Loc Engng—Feb., 1908. No. 89989 C.

Wabash 2-6-2 Fast Freighter. Illustrated description of one of the 30 engines recently supplied to this road for fast freight service. 1000 w. Ry & Loc Engng—Feb., 1908. No. 89986 C.

Ten-Wheel Switching Locomotive for the Big Four. Illustrated description of engines for service in the classification yards. 500 w. Ry Age—Feb. 21, 1908. No. 90439.

A High-Power European Locomotive. Charles R. King. Illustrated description of a powerful locomotive built in Bavaria for use on the State Railways. 600 w. Sci Am—Feb. 15, 1908. No. 90193.

Ten-Wheel Locomotive for the Texas & Pacific. Illustrated description of engines for mixed service. 300 w. Ry Age—Feb. 14, 1908. No. 90223.

L. & S. W. Locomotive, No. 335. Illustrated detailed description of the largest engine on the London and South-Western Railway. 900 w. Engr, Lond—Feb. 7, 1908. No. 90260 A.

The New Great Western Locomotive. Illustrates and describes the latest development in locomotives for a road celebrated for its high speed, long-distance non-stop runs. 500 w. Engr, Lond—Feb. 14, 1908. No. 90504 A.

Rack Locomotive for the Villa Nova de Gaya Railway, Portugal. Illustrated detailed description. 600 w. Engng—Feb. 14, 1908. No. 90497 A.

Tank Locomotives for the Southern Manchuria Railway. Illustrated description of one of 69 tank engines built in America. 500 w. Ry Age—Feb. 7, 1908. No. 90118.

The Brotan Locomotive. William C. Dreher. Illustrated description of this locomotive boiler, with a water-tube firebox, used on the Austrian State Rys., and statement of the advantages claimed. 2000 w. R R Gaz—Feb. 14, 1908. No. 90225.

High-Speed Compound Locomotive for the Eastern of France (Locomotive Compound à Grande Vitesse de la Compagnie des Chemins de Fer de l'Est). Ch. Dantin. Illustrated description. 3000 w. Génie Civil—Jan. 18, 1908. No. 90334 D.

See also Gasoline Locomotive, under MOTIVE POWER AND EQUIPMENT.

Locomotive Testing.

The Testing of a Locomotive. Frederic Blount Warren. Brief illustrated description of the plant at Altoona, Pa., and its operation. 2200 w. Sci Am—Feb. 22, 1908. No. 90477.

Problems.

See same title, under CONDUCTING TRANSPORTATION.

Shops.

Building Wooden Freight Cars. An account of the organization and operation of the part of the Angus shops of the C. P. R. devoted to the construction of freight cars. Describes the building of a standard box car. Ills. 2500 w. Am Engr & R R Jour—Feb. 1908. No. 89991 C.

Superheating.

The Development of Superheating Apparatus for Locomotives. J. F. Gairns. Reviews the history of the superheater locomotive, giving illustrated descriptions of European and American practice. 6000 w. Cassier's Mag—Feb., 1908. No. 90273 B.

Wheels.

The Shelling Out of Steel Wheels and Tires. George L. Fowler. An illustrated account of investigations made for the Schoen Steel Wheel Co. 1200 w. R R Gaz—Jan. 31, 1908. No. 89942.

The Car Wheel and Its Relation to the Rail and Car. S. P. Bush. Considers facts concerning car wheels and the conditions of operation in the past and present, discussing the needed improvement of quality. Discussion. Ills. 20000 w. Pro W Ry Club—Jan. 21, 1908. No. 90423 C.

See also Rails, under PERMANENT WAY AND BUILDINGS.

Valve Gears.

Tests of Cast-Iron Distributing Valves on the Locomotives of the Orléans Railway (Essais de Tiroirs de Distribution en Fonte sur les Locomotives de la Compagnie d'Orléans). Paul Conte. Gives results of extensive tests aiming toward the substitution of cast iron for bronze in locomotive valve gears. Ills. 2400 w. Rev Gen de Chem de Fer—Jan., 1908. No. 90320 G.

NEW PROJECTS.

Switzerland.

The New Alpine Railways and Their Branches in Switzerland (Die neuen Alpenbahnen und Zufahrtlinien in der Schweiz). H. Cox. Discusses especially their economic importance to Germany. Ills. 3200 w. Serial, 1st part. Zeitschr d Ver Deutscher Ing—Jan. 4, 1908. No. 90380 D.

We supply copies of these articles. See page 158.

PERMANENT WAY AND BUILDINGS.

Ballast.

See Tracks, under PERMANENT WAY AND BUILDINGS.

Construction.

The Construction of the Portland & Seattle Railway. W. P. Hardesty. Describes the physical characteristics of the country and gives an illustrated detailed description of the very costly construction work. 5000 w. Eng News—Feb. 13, 1908. No. 90163.

Elevated Railways.

The Fortieth Street Track Elevation of the Chicago Junction. Map, and illustrated detailed description of this work. 1500 w. R R Gaz—Feb. 21, 1908. No. 90447.

Improvement of the Union Loop, Chicago. Charles K. Mohler. Gives a tentative plan for the improvement and extension of the elevated service, explaining the purpose and the advantages to be gained. 2000 w. Ry & Engng Rev—Feb. 8, 1908. No. 90119.

Freight Sheds.

See Terminals, under TRAFFIC.

Grade Reduction.

Operating Time as an Element in Considering Grade Reductions. Abstract of an article by A. K. Schurtleff in the *Bul. of the Am. Ry. Engng. & Main. of Way Assn.* 2000 w. Eng Rec—Feb. 1, 1908. No. 89962.

Protective Materials.

The Best Means of Preserving Iron and Steel Work in Railway Construction. Bertram Blount. Paper and discussion at the Engng. Conference, 1907. 5300 w. Bul Int Ry Cong—Jan., 1908. No. 90284 E.

Rails.

A Compound Rail Section. A. W. Heinle. A critical discussion of the design and rolling of rails. 2000 w. R R Gaz—Jan. 31, 1908. No. 89941.

The Chemical Composition of Steel Rails and Latest Developments. Christer Peter Sandberg. (Inst. of Civ. Engrs.) Short paper, with discussion of this subject. 36400 w. Bul Int Ry Cong—Jan., 1908. No. 90282 E.

The Action Between Wheel and Rail. Henry Reginald Arnulph Mallock. Paper and discussion before the Engng. Conference, 1907. An account of conclusions from an examination of the mutual action. 7200 w. No. 90285 E.

The New Types of Rails on the Italian State Railways (I Nuovi Tipe di Armamento dello Ferrovie dello Stato). Gives extensive details of composition, of section, manufacture, cost, etc. Ills. 5500 w. Ing Ferroviaria—Jan. 16, 1908. No. 90340 D.

Roundhouses.

The Roundhouse of the Lehigh & Hudson River Railway at Warwick, N. Y. Illustrated description. The interesting feature is the special combination of steel, concrete and wood used in the framework. 1000 w. Eng Rec—Feb. 8, 1908. No. 90096.

Stations.

New Orleans Terminal Station. Illustration, plans, and brief description. 300 w. Ry Age—Feb. 14, 1908. No. 90221.

Large Railway Stations. The first of a series of articles on the large stations of Great Britain. The Paragon station at Hull, is illustrated and described. 3000 w. Engr, Lond—Feb. 14, 1908. Serial, 1st part. No. 90501 A.

Terminals.

Wabash Freight Terminal at St. Louis. Illustrated detailed description. Freight is handled on a tonnage basis. 1200 w. Ry Age—Feb. 7, 1908. No. 90117.

Solving the Terminal Problem at St. Louis. Map, and description of the methods that have been followed and the results secured and sought. 2800 w. Ry Age—Feb. 14, 1908. Serial, 1st part. No. 90220.

Ties.

The Iron Sleeper. A. Haarman. Gives a report of the efficiency of iron sleepers on the Prussian State Railways, and discusses their cost, advantages, etc. Ills. 3800 w. Engr, Lond—Feb. 21, 1908. Serial, 1st part. No. 90672 A.

Tracks.

Track and Ballast. H. Rettinghouse. Remarks on the essentials of good tracks, discussing each in detail. Also paper on same subject, by R. R. Aurbach. General discussion. 16000 w. Pro Iowa Ry Club—Jan. 10, 1908. No. 90550 C.

Transfer Bridges.

The Weehawken Transfer Bridges of the West Shore Railroad. Illustrated description of bridges for the service of handling cars by means of floating equipment. 3000 w. Eng Rec—Feb. 15, 1908. No. 90203.

Yards.

Wath Concentration Yard, Great Central Railway. Illustrated description of the large yard at Wath-on-Dearne, for the sorting of coal cars, both loaded and empties. 2000 w. Engr, Lond—Feb. 7, 1908. No. 90263 A.

TRAFFIC.

Car Sealing.

Car Seals. Charles J. Webb. Read before the Chicago Claim Conference. Considers the methods that give the best results. 1000 w. Ry Age—Feb. 14, 1908. No. 90222.

We supply copies of these articles. See page 158.

Management.

The Railway Profession; Some Important Problems and Their Handling. H. Wade Hibbard. Discusses the improvements made necessary by increased traffic and changed conditions, and the methods of best accomplishing the work. Short general discussion. 9000 w. S & S-W Ry Club—Nov. 21, 1907. No. 89842 E.

Tonnage Rating.

Tonnage Rating by Ton Mile Hour Basis. C. A. Seley. Remarks on the advantages of this method, with general discussion. 4000 w. Pro Iowa Ry Club—Dec. 13, 1907. No. 90184 C.

MISCELLANY.

Africa.

The Soudan Railroad from the Red Sea to the Nile. H. G. Prout. An interesting letter giving early history of this project. 900 w. R R Gaz—Feb. 21, 1908. No. 90446.

The Railroad from the Red Sea to the Soudan. From a letter by Frank G. Carpenter, describing this new railroad which the British have built from Atbara to Port Soudan. 1800 w. R R Gaz—Feb. 14, 1908. No. 90227.

The Otavi Railway. A. R. Bell. An illustrated account of the longest narrow gauge light railway in the world. 1200 w. Ry & Loc Engng—Feb., 1908. No. 89985 C.

British Railways.

British Railway Development, Past and Present. F. A. Lart. A discussion of the present status of British railways and some of the tendencies. 3500 w. Cassier's Mag—Feb., 1908. Serial, 1st part. No. 90275 B.

Canada.

Western Canada and the Canadian Northern Railway. From an address by D. B. Hanna before the Empire Club of Toronto. 2500 w. R R Gaz—Jan. 31, 1908. No. 89943.

Government Control.

The Regulation of Local Lines and Tramways and the Supervision of Their Tariffs (Note sur la Réglementation des Chemins de Fer d'Intérêt Local et des Tramways et sur la Rédaction de leurs Cahiers des Charges). A. Donoil. An elaborate discussion of the French law on the subject. 27000 w. Rev Gen d Chemins d Fer—Dec., 1907. No. 89720 G.

Adverse Railroad Legislation. Papers by Nathaniel S. Brown and by Herbert S. Hadley, with letters from other writers. 18700 w. Pro St Louis Ry Club—Jan. 10, 1908. No. 89901.

History.

A Decade of American Railroad History in Graphic Form. Harold Vinton Coes. Gives charts showing growth, operation and equipment, and finances, with explanatory notes. 1500 w. Engineering Magazine—Feb., 1908. No. 89883 B.

India.

Indian Railway Economics. The present number reviews the history of the railways in India down to recent times. 2000 w. Engr, Lond—Jan. 10, 1908. Serial, 1st part. No. 89660 A.

Interstate Commerce.

Interstate Commerce Report. Extracts from the last annual report which covers the first year's work under the 1906 Rate Law. Also editorial. 5000 w. R R Gaz—Jan. 10, 1908. No. 89444.

Annual Report of the Interstate Commerce Commission. Deals with portions of the report not considered in an earlier issue. 5000 w. R R Gaz—Feb. 7, 1908. No. 90078.

Light Railways.

Light-Railway Policy. William Barrington. Paper and discussion before the Engng. Conference, 1907. 7900 w. Bul Int Ry Cong—Jan., 1908. No. 90287 E.

Panama Railway.

Panama Railway and Its Relations to the Panama Canal. Ralph Budd. Also discussion. An account of the work in progress. 8500 w. Pro Iowa Ry Club—Nov. 8, 1907. No. 90183 C.

Peru.

The Railroads of Peru. J. R. Cahill. Map and illustrated account of the development and working of the railways. 3500 w. R R Gaz—Feb. 7, 1908. No. 90081.

Philippines.

Railroad Construction in the Philippine Islands. L. F. Goodale. An illustrated account of the lines, especially those built since the U. S. control; the methods used in construction work are described. 3000 w. Ry Age—Jan. 31, 1908. No. 89976.

Seaboard Line.

Seaboard Air Line. Reviews the recently issued annual report. Also editorial. 3000 w. R R Gaz—Jan. 10, 1908. No. 89442.

Southern Pacific.

Southern Pacific Company. Map, with review of the 23d annual report for the year ending June 30, 1907. 3000 w. R R Gaz—Feb. 14, 1908. No. 90224.

Union Pacific.

Union Pacific. Review of an interesting annual report showing progress. 3300 w. R R Gaz—Jan. 3, 1908. No. 89342.

Transportation.

Relations of Transportation to Modern Civilization and Its Bearing on the Question of Co-operation. F. A. Delano. An address before the Traffic Club of St. Louis. Shows that the transportation problem is related to the welfare of the whole country. 3300 w. Ry Age—Feb. 21, 1908. No. 90440.

We supply copies of these articles. See page 158.

STREET AND ELECTRIC RAILWAYS

Brakes.

Fundamental Brake Rigging for High Speed Electric Railway Cars. R. C. Taylor. Report to the Cent. Elec. Ry. Assn. on foundation gear for high-speed interurbans, including only the apparatus from the air-brake cylinder to the wheels. 900 w. St Ry Jour—Feb. 1, 1908. No. 89946.

Canada.

Electric Railways in Canada. J. L. Payne. An interesting review of progress and development. 1800 w. St Ry Jour—Feb. 1, 1908. No. 89945.

Car Houses.

New Car House Construction in New York. Plans and description of a rebuilt structure at 146th St. and Lenox Ave. 800 w. St Ry Jour—Feb. 8, 1908. No. 90076.

Cars.

Pay-as-You-Enter Cars for Mexico. Illustrated description of cars of the double-center entrance type. 700 w. Elec Ry Rev—Feb. 22, 1908. No. 90445.

The Brooklyn Rapid Transit Company's Type "1400" Elevated Car. Illustrated description of cars of the semi-convertible type. 1400 w. St Ry Jour—Feb. 8, 1908. No. 90077.

Long Single-Truck Cars Without Monitors. Descriptions and illustrations of types used by the Black River Traction Co., with criticisms by T. J. Nicholl, and replies by A. H. Lefevre. 2500 w. Elec Ry Rev—Feb. 1, 1908. No. 89999.

Notes on the Black River Traction Company of Watertown, N. Y. A. H. Lefevre. Illustrated detailed account of interesting improvements introduced in line and equipment. 3000 w. St Ry Jour—Feb. 8, 1908. No. 90075.

Typical Traction Cars. Charles A. Heron. Abstract of a paper read before the Indiana Engng. Soc., on the dimensions, weight and seating capacity of typical cars now operated. 1000 w. Elec Ry Rev—Feb. 1, 1908. No. 90000.

See also Subway Cars, under STREET AND ELECTRIC RAILWAYS.

Car Wiring.

Equipping New York's Pay-as-You-Enter Cars. Plans and description of car-wiring representing the latest practice. 900 w. St Ry Jour—Feb. 15, 1908. No. 90173.

Controllers.

Controller Handle Button. Describes the electric controller with safety button and emergency brake valve, used on the trains in the N. Y. subway. Ills. 1500 w. Ry & Loc Engng—Feb., 1908. No. 89987 C.

Economics.

The Economics of Rapid Transit in Cities (Zur Frage der Wirtschaftlichkeit städtischer Schnellbahnen). Herr Kemmann. Discusses conditions in the European and American cities which have established elevated and underground railways. Ills. 5000 w. Glasers Ann—Jan. 15, 1908. No. 90360 D.

Elevated Railways.

See same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS; and Economics, under STREET AND ELECTRIC RAILWAYS.

France.

See Government Control, under RAILWAY ENGINEERING, MISCELLANY.

Interurban.

Interurban Railways. Hugh J. McGowan. From an address before the Nat. Business League of America. Some facts in regard to the development and benefits resulting from such service. 1800 w. Munic Engng—Feb., 1908. No. 90182 C.

The Northampton Traction Company. Illustrated description of lines in eastern Pennsylvania, passing through picturesque scenery. Running from Easton to Nazareth and Bangor, and from Easton to Allentown and Philadelphia. Map. 2000 w. St Ry Jour—Feb. 1, 1908. No. 89944.

The Indianapolis & Louisville Traction Co. Illustrated description of a road operated on direct current at 1,200 volts pressure. 2500 w. Ry & Engng Rev—Feb. 8, 1908. No. 90120.

Electric Trunk Lines (Elektrische Vollbahnen). Herr Zweiling. Illustrates and describes rolling stock for both direct and alternating-current operation in Europe. 3000 w. Serial, 1st part. Glasers Ann—Jan. 15, 1908. No. 90361 D.

See also Single-Phase, under STREET AND ELECTRIC RAILWAYS.

Monorail.

The Tunis Monorail System. Illustrates and describes the general features. 1000 w. Sci Am—Feb. 15, 1908. No. 90192.

Montreal.

The Montreal Street Railways. Describes the conditions, and gives an account of the system, management and financial condition of the street railway lines. Ills. 1800 w. Tram & Ry Wld—Feb. 6, 1908. No. 90416 B.

Motors.

See Railway Motors, under ELEC-

We supply copies of these articles. See page 158.

TRICAL ENGINEERING, DYNAMOS AND MOTORS.

Operation.

See Cars, under STREET AND ELECTRIC RAILWAYS.

Paris.

The Métropolitan of Paris (Le Métropolitain de Paris). A. Dumas. A description of the lines built and authorized with a discussion of the financial results. Map. 6500 w. Génie Civil—Jan. 25, 1908. No. 90336 D.

Porto Rico.

Tramway and Power Developments in Porto Rico. An illustrated account of improvements in transportation facilities since the American occupation. 2000 w. St Ry Jour—Feb. 22, 1908. No. 90422.

Schedules.

Electric Train Performance. W. S. Valentine. Describes a method in which, by the use of a celluloid templet, the amount of work, entailed in the usual methods of computing coasting distance, practiced by engineers, is greatly reduced. 1200 w. Elec Jour—Feb., 1908. No. 90426.

Single-Phase.

The Roma Civita Castellana Single-Phase Railway. B. F. Hirschauer. Illustrated description of the first single-phase railway in Italy. 2200 w. Elec Rev, N Y —Feb. 15, 1908. No. 90197.

The Washington, Baltimore & Annapolis Single-Phase Railway. Illustrated detailed description of this new high-speed line. 4000 w. St Ry Jour—Feb. 15, 1908. No. 90172.

The Oerlikon System of Single-Phase, Alternating-Current Electric Traction on European Railways (La Traction Electrique par Courant Alternatif Simple sur les Chemins de Fer en Europe, Système Oerlikon). M. Henry. Illustrated detailed description. 2000 w. Serial, 1st part. Jan. 4, 1908. No. 90324 D.

See also Electrification, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Subway Cars.

Report on Subway Car Design in New York. Abstract of the report of Bion J. Arnold to the Public Service Commission. 4500 w. St Ry Jour—Feb. 29, 1908. No. 90568.

Subways.

The Hudson and Manhattan Tunnels. Map, illustrations, and brief description of the lines to be opened on Feb. 25, 1908. 1200 w. R R Gaz—Feb. 21, 1908. No. 90448.

Opening of the Hudson River Tunnel System. Brief illustrated account of this project, its completion, equipment, etc. 1200 w. St Ry Jour—Feb. 29, 1908. No. 90566.

Opening of the Hudson River Tunnel System. An illustrated description of this great work, with brief review of its history. 2800 w. Sci Am—Feb. 22, 1908. No. 90476.

The Opening of the First Hudson River Tunnel. Outlines the history of this work, and describes the difficulties, and the tunnel system as finally completed. Map and Ills. 5000 w. Eng News—Feb. 27, 1908. No. 90524.

Tunnels for Passenger Traffic at New York City. Editorial on some features of design and equipment of cars for tunnel service and matters relating to tunnel operation. 1300 w. Eng News—Feb. 27, 1908. No. 90523.

The Beginning of Train Service Under the Hudson River at New York. Brief account of the opening, and illustrated description of the work. 1800 w. Eng Rec—Feb. 29, 1908. No. 90609.

The Opening of the Hudson River Tunnels. An account of the opening of the tunnels between Jersey City and New York, with brief illustrated description of this great engineering work. 4000 w. Sci Am Sup—Feb. 29, 1908. No. 90601.

Proposed Track Changes at Ninety-Sixth Street, New York Subway. Report of proposed changes at the junction of the Broadway and Lenox Ave. divisions to relieve congestion of traffic. 1000 w. St Ry Jour—Feb. 29, 1908. No. 90569.

A New Subway in Paris. Brief illustrated description of a line about 8½ miles long being driven from north to south and passing under the Seine river. 1500 w. Sci Am Sup—Feb. 15, 1908. No. 90585.

See also Economics and Paris, under STREET AND ELECTRIC RAILWAYS.

Subway Signalling.

Signalling of the East River Tunnels, New York. Illustrated description, calling attention to variations from practice in the N. Y. subway. 2000 w. R R Gaz —Feb. 28, 1908. No. 90597.

Switzerland.

See same title, under RAILWAY ENGINEERING, NEW PROJECTS.

Track Construction.

The Problem of Track Support. Samuel E. Duff. An investigation of the track as a whole, discussing designs. Ills. 3500 w. Ry & Engng Rev—Feb. 22, 1908. No. 90442.

Wire Suspension.

Catenary Construction on the Syracuse, Lake Shore, and Northern Railroad. Illustrated description of catenary construction designed for single-phase current at 6,600 volts. 1000 w. Elec Ry Rev—Feb. 8, 1908. No. 90111.

We supply copies of these articles. See page 158.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Science. *w.* Denver, U. S. A.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Elevators.

Elevator Service. By Reginald Pelham Bolton. Size, 11 by 8 in.; pp. 69. Ills. Price, $5. New York: Reginald Pelham Bolton.

From his wide experience as a consulting engineer in this class of work Mr. Bolton has been able to produce in this small volume a clear and concise discussion of the principles on which elevator equipment for the modern high office building should be designed, to which we have no hesitation in giving our heartiest commendation. In his introductory chapter he shows clearly the limitations of elevator service, their causes and character, and the necessity for the recognition of these limitations in the establishment of a standard rating for use both in design and in checking operating results. In the remaining chapters Mr. Bolton discusses in a very practical manner the proportioning of the elevator equipment to the building it is to serve and the influence of operating conditions, size and shape of cars, loads and speeds, and all the other elements in the problem of vertical transportation on the efficiency of elevator service. One of the most valuable features of the book is the inclusion of a large number of data obtained in actual practice in New York City, where the conditions of service are probably more severe, and elevator equipment more highly developed, than anywhere else.

Railway Operation.

The Economics of Railway Operation. By M. L. Byers. Size, 9 by 6 in.; pp., ix, 672. Ills. Price, $5. New York: The Engineering News Publishing Company; London: Archibald Constable & Company.

This addition to the literature of the science of transportation should meet with a cordial reception by all classes of railway men. Its general objects are, for the student, to so outline the operations of each department as to give those unfamiliar with their workings a sufficient insight to form the basis for the detailed information which can be acquired only by personal observation and experience; and, for the official, to bring into clear relief the underlying principles of economic operation in so far as they will enable him to increase the efficiency of his own department and gain a clearer idea of its relation to the other elements of the railway organization. The book is divided into seven parts, dealing, respectively, with organization; employment, education and discipline of forces; accounts and accounting; reports; economic operation; analysis of operations; and betterments. Mr. Byers has not written only from his own experience on the Missouri Pacific, but has drawn his illustrations liberally from the operating practice of many other roads. He has produced a very valuable review of the present development of railway transportation methods in the United States which will well repay careful study.

BOOKS RECEIVED.

The Geological Map of Illinois. By Stuart Weller. Size, 9 by 6 in.; pp., 34. Map. Urbana, Ill.: Illinois State Geological Survey.

Rapports Annuels de l'Inspection du Travail. Size, 10 by 7 in.; pp., 441. Ills. Price, fr. 4. Brussels: Department of Industry and Labor.

Statistics of the American and Foreign Iron Trades for 1906. Size, 9 by 6 in.; pp., 88. Philadelphia: The American Iron and Steel Association.

Annual Report of the Park Department of the City of Cambridge, 1907. Size, 9 by 6 in.; pp., 37. Ills. Cambridge, Mass.: Department of Parks.

Third Annual Report of the Highway Department of the State of Ohio. Size, 9 by 6 in.; pp., 288. Ills. Columbus, O.: Department of Highways.

Annual Reports of the Department of the Interior, 1906; Commissioner of Education, Vol. 2. Size, 9 by 6 in.; pp., 644-1308. Ills. Washington, D. C.: Department of the Interior.

Proceedings of the Society for the Promotion of Engineering Education, Cleveland Meeting, 1907. Size, 9 by 6 in.; pp., 690. Ills. Brooklyn, N. Y.: Published by the Secretary.

Annual Report of the Department of Public Works of the City of Buffalo for the Year Ending June 30, 1907. Size, 9 by 6 in.; pp., 1053. Buffalo, N. Y.: Department of Public Works.

A Study of Four Hundred Steaming Tests Made at the Fuel-Testing Plant, St. Louis, Mo., in 1904, 1905, and 1906. Size, 9 by 6 in.; pp., 196. Ills. Washington, D. C.: United States Geological Survey.